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FIG I. NIGHT PHOTO OF PATTERN SHOP LIGHTED WITH HIGH PRESSURE GAS.

HIGH PRESSURE GAS LIGHTING IN BRITISH SHOPS*

BY I. W. CHUBB.

The high pressure system of gas lighting has been applied in Great Britain in many directions, not only for the ordinary public lighting, but also for large semi-public places, such as railway stations, and further in many industrial directions.

In the Keith system here spoken of the normal pressure is 80 in. of water, or say 3 lb. to the square inch. To meet the special requirements of some textile mills a pressure of 10 in. water gage is sometimes employed. The object is to insure at least a reasonable light should the pressure fail from any cause. In such a case gas from the mains at, say, 2 in. of water would still pass through the compressor (centrifugal), though of course the full light would only be given at the 10 in. pressure.

The compressed gas is admitted to inverted incandescent burners which, for the 10 in. pressure, are of one size only, 100 cp., taking 2 cu. ft. of gas per hour; thus giving 50 cp. per

*Condensed and rearranged from American Machinist.

cu. ft. per hour. On the 80 in. pressure the efficiency should be 60 cp., except in the case of the smaller lamps. Regarding upkeep, larger lamps require four or five mantles and one globe per year as an average.

The total amount of light supplied naturally varies according to the character of the work, and each case is considered on its own merits; but for average engineering shops the allowance is about 1 cp. per sq. ft. of floor space, a 1000 cp. lamp placed, say, 12 ft. high, covering 1000 sq. ft. This gives 3 ft. candles at about 3 ft. above the ground, but in some cases it is necessary to go much beyond this.

The lamps range from 60 cp. upward, and above 150 cp. the standard efficiency is 60 candles per cu. ft. Up to 1500 cp. units single mantles are fitted, but two and three-mantle lamps up to 4500 cp. units are available. For lathes and similar machines, over benches, etc., 60 cp. fittings, with copper spring antivibration pendants are usual. Generally, however, for machine lighting 100 and 150 cp. units, see Fig. 2, are employed, while for shops with overhead cranes, bigger units, 1000 cp. and 1500 cp. suspension lamps are employed, and they may be controlled by automatic distance lights, governed by bypass cock, plain lever cock or low pressure bypass.

The action of the lamp will be best understood from Fig. 3, which gives a section of the single-burner suspension type. The lamp is suspended, a tube at the top carrying the gas nipple and a dust trap. Gas under pressure passes down the venturi tube shown and by injector action takes in the required quantity of air, the mixture being delivered to a heater below. The high-pressure gas draws in a larger volume of air than is possible with low-pressure gas and consequently a highly aërated mixture passes down the tube. Adjustment of air is provided by a screw across the tube, the head projecting outside the casing. This, it is explained, acts as a throttle to the induced air, but the gas, being under pressure, is not affected. The throttle thus allows for variations of supply according to the quantity of the gas.

FLAME SMALLER IN HIGH-PRESSURE LIGHTING.

The size of the flame is smaller proportionately than with low-pressure gas, because the flame from gas already sufficiently aërated does not have to seek for its proper supply of air. Therefore, the flame is more intense at its surface where it reaches the mantle. The latter is proportioned to fit the flame. Before passing to the burners, the gas mixture is heated, two shallow cones being fixed base to base with a diaphragm between. The latter is perforated toward the outer edge. The gas mixture impinges on this flat diaphragm and then passes through the holes, spreading over highly heated surfaces before passing to the nozzle In the larger units, each lamp has a thermostat, a compound strip of brass and a low heat-expansion alloy being secured at one end to the heater, while the other end bears a disk which, when the strip is cold, almost covers an air inlet. An adjusting screw prevents entire closure. The resistance to air entry is automatically reduced with the warming of the lamp. This insures the lamp lighting quietly.

For lighting individual lamps at a height, flashing torches will give a blue flame 1 ft. long, methylated spirit contained in a reservoir being blown across a permanent flame by the action of pressing a rubber bulb. For controlling a string of lamps on the high pressure gas system an automatic lighter, shown in sections in Fig. 4, is employed. Here a silver diaphragm controls the passage of the gas. If the pressure is sufficient the diaphragm and spring-controlled plunger behind it are pressed back, the extent of the diaphragm movement being about 1-64 in. With reduction of pressure the diaphragm returns to its seating.

These automatic lighters are fitted to lamps placed, for instance, above cranes. As the high pressure gas is turned on, the silver diaphragm moves off its seat and allows the gas to reach the main burner, which is then ignited by the permanently burning pilot light, a flash occurring simultaneously.

A GOVERNOR CONTROLS THE LIGHT.

A governor controls the pilot light on the ordinary lamps so that its size remains the same whether pressure is on or not. By turning a lever the pilot is momentarily enlarged to insure the lighting of the main burner. The cock, Fig. 5, generally employed on suspension lamps, has a silver diaphragm controlling the bypass flame supply, the flame size being regulated by the screw on top. The

diaphragm is held slightly off its seat by a spring. On admission, gas passes by the port to the opposite side of the diaphragm, and then through the valve opening to the outlet for the bypass. The port being throttled somewhat by the screw, the tendency of the pressure difference is to close the gas outlet. This, however, would raise the lower pressure and thus, in conjunction with the spring, give the effect of balance, the difference of pressure between inlet and outlet being maintained whatever the actual supply pressure.

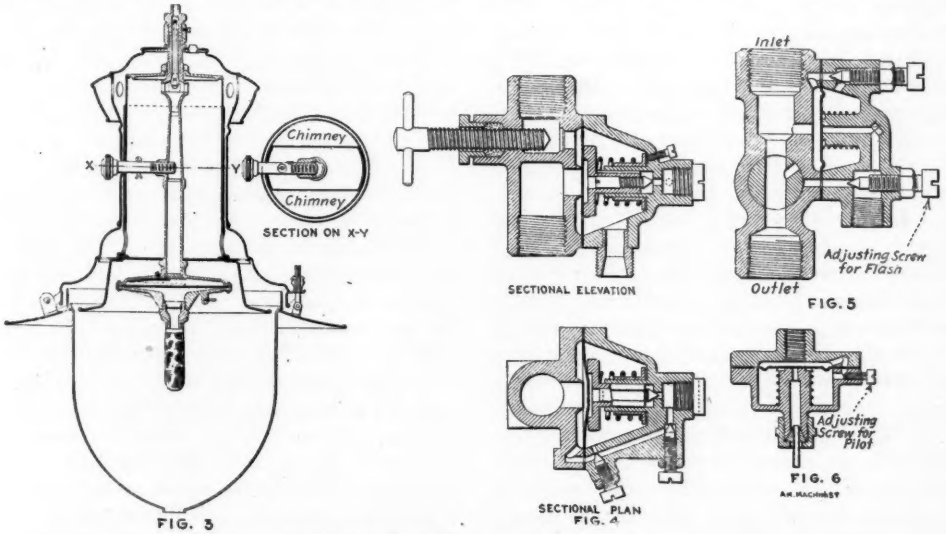
Thus for any given position of the regulating screw approximately the same quantity of gas will always pass. For the flash a small port shown in the plug communicates with a passage to the bypass when the cock is turned half-on, giving a further supply of gas to the bypass flame at the moment of turning on. If a bypass governor is required apart from the cock the form shown in Fig. 6 is employed.

HIGH PRESSURE GAS FOR OTHER SERVICE THAN LIGHTING.

High pressure gas is used also to a considerable extent in Great Britain for industrial purposes other than lighting, and the same means of compression are employed. Soldering irons have an internal bypass cock to control the heat, and removable solid copper bits held by a setscrew; and as the air supply can be controlled and set by a ring, high efficiency can be obtained with uniform heat. All classes

FIG. 2. HIGH PRESSURE GAS LAMP.

of gas-heated furnaces can be adapted for high-pressure gas, several in the works of the Keith & Blackman firm, for example, being employed for bending angle iron used for the frames of the ventilating fans also made by them. The ignited mixture of gas and air is



DETAILS OF LAMP AND CONNECTIONS.

passed downward on to the article to be heated.

THE HIGH PRESSURE SYSTEM APPROVED.

Inquiry among a number of engineering firms in Great Britain who are lighting their shops by this system developed that they are at least satisfied. An automobile firm in the London district is using 1000-cp. lamps, which, however, it rates somewhat lower. The average consumption of gas is about 16⅔ cu. ft. At 2s. 5d. (58c.) per 1000 cu. ft. this represents less than ½d. (1c.) per nominal 1000 cp.-hr. Maintenance costs about 25s. ($6) per 1000-cp. motor per annum. Another motorcar firm nearer the Midlands of England has had the system at work for some two years in its new works. The high-pressure gas system was installed after considerable trouble in inspecting installations, and after a consideration of the results obtained with the electric lighting in the older works of the same firm. This company reports that the system has proved fully up to expectation, both as regards cost of gas against current and cost of upkeep.

The main floor of this factory measures 130x125 ft. This is lighted by 20 lamps each of 1000 cp. No individual lamps are fitted, and it is found that with these comparatively large units a good general light is given, and that no extra lights are required at any of the machine tools or on the fitting benches. The shop has four bays, the lamps being hung centrally in them and staggered, and it is asserted that no cross-shadows are obtained, while the light at night is thought to be little inferior to ordinary daylight. In stores, drawing and other offices, similar lamps are installed, ranging from 60 cp. to 300 cp.

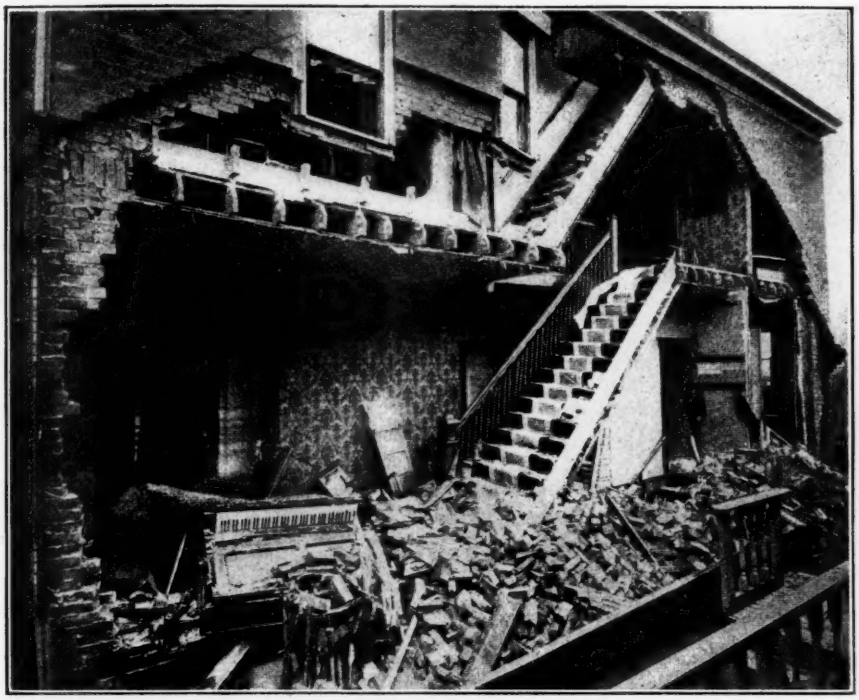
As the result of a number of tests, using gas at 2s. 3d. (54c.) per 1000 cu. ft. it is found that with all the lamps lighted the cost is just about 1s. (24c.) an hour. As to upkeep no record has been kept, this not being thought worth while. The light is found pleasant to work by, and it is asserted that 100 cp. in incandescent gas light is more effective than 100 cp. in electric light of any form previously tried, namely, incandescent, arc, or flame-arc lamps. One small difficulty has been overcome. It was found that some amount of oil from the compressor worked up the pipes and gradually clogged the nipples of the lamps, which, therefore, required cleaning. A trap has, however, been fitted, and little or no trouble is being experienced.

A Glasgow firm of engineers specializing largely in centrifugal machinery has the shops lighted by lamps which vary from 300 to 1500 cp., the total amounting to 40,000 cp. The consumption is 727 cp. of gas an hour, giving an efficiency of 55 cp. per cu. ft. The price of gas being 1s. 11d. (46c.), the consumption per hour costs say 1s. 5d. (34c). Driven by electric motors, two gas compressors are employed, each with a maximum capacity of 1000 cu. ft. an hour. These are run alternately, the cost for power and oil being at the rate of 2¼d. (5c.) an hour. This firm considers that the lamps give a good light, but that attention is required to keep them and the gauzes clean. It is, therefore, important that they should be in such a position that they can be easily reached.

A gas stove and meter company has had a Keith-Blackman high-pressure lighting installation in use for about 18 months. The compressor is direct-driven by electric motor and the gas pressure is 54 in. The actual present lighting is more than 11,000 candles, distributed over 76 lamps, which range in candlepower from 60 to 300. The hourly gas consumption is about 552 cu. ft. and with gas costing 1s. 11d. (46c.) per 1000 cu. ft. this means rather more than 1s. (24c.) an hour. The average life of the mantles in constant use is two months, and the average cost of renewals for the lamps is about 3s. (72c.) a week. The cost of cleaning the lamps weekly for the complete installation is about 3s. (72c.), and in adition there is a small charge for current for driving the compressor, oil, etc.

EXPLOSION OF NATURAL GAS

The half-tone here reproduced from *Safety Engineering* shows what happened to a house in Cincinnati. The other side of the house was wrecked in the same style and also the rear of it. The house was piped with natural gas which was used for lighting, heating and cooking. The family retired early and the crash came about midnight. The oven of the kitchen gas range had been left lighted to take the chill off the rooms. Instead, the rooms were taken off, and fire insurance did not cover the loss. Perhaps as curious as any part of it was that no one of the five in family was hurt.



RESULT OF NATURAL GAS EXPLOSION.

HIGH PRESSURE GAS FOR CITY LIGHTING

Mr. F. V. Westermaier, the well known gas expert of Philadelphia, recently talked upon the above topic before the City Club of Chicago, some portions of his discourse being here reproduced.

The American traveler, he said, seeing for the first time at night the streets of Berlin, is amazed at the abundance of light in which they are bathed. Unconsciously he compares their illumination with that of the best lighted streets in America and concludes rashly that Berlin is extravagantly wasteful, but later he sees the wisdom of it.

Since the Franco-Prussion war Berlin has been practically rebuilt. Its development has been along lines to promote efficiency, civic beauty, public health and safety, and it stands to-day as the most modern of cities. The residential districts have been generally removed from the manufacturing and commercial centers and each has been planned to expand without crowding the others.

As the city grew in size the lighting of the streets increased in importance. The influence of an abundance of light as a protection against crime was recognized, and in addition to this the ever increasing vehicular traffic, the cleaning of streets and the removal of refuse and garbage at night required adequate illumination.

Owing to the fact that on the regular low presure gas units were limited to a maximum of 400 candle power, electric arc lamps of the flaming type seemed to have the advantage, but through the development of special lamps using gas at two pounds instead of two ounces pressure, the efficiency of incandescent gas lighting was increased three-fold; moreover, it was possible to produce units capable of giving from 500 to 4,500 candle power. Trial installations of these lamps were made, and as a result of several year's tests, high pressure gas lighting was decided upon for Berlin's principal streets, because it fulfilled all the requirements for quantity and quality of light, economy of operation and absolute reliability.

The adoption of high pressure gas lighting to replace existing low pressure gas units and electric lamps on the important thoroughfares

required the installation of special high pressure mains connecting the lamps with the compressor plants at the different gas works. For this purpose five inch Mannesman steel tubes were laid inside the curbs and driven under intersecting streets so that the paving would not be disturbed.

Direct connected gas engine driven compressors in duplicate raise the gas from 2½ ounces to 2½ pounds pressure and deliver it to the lamp system. The cost of compression is very low: the ratio of gas used in the engines to the gas compressed is as 1 is to 100. The pressure is automatically held constant and the compressor plants at the different gas works are so connected that one set or all can supply the lamps as a precautionary measure.

SATISFACTION—LARGER APPROPRIATION.

The municipality of Berlin was so well satisfied with the character of high pressure gas lighting, its flexibility, and fitness for the street system, that it appropriated the sum of seven million marks ($1,660,000) for the extension of the system. The expenditure is made at the rate of one million marks a year to pay for main extensions and lamps, and the entire installation will be completed by 1915. In 1905 there were four miles of streets lighted by high pressure gas units; in 1911, 37 miles, and at the present time about sixty miles.

LARGE CITIES FOLLOW EXAMPLE.

Since the installation of high pressure gas lighting in Berlin, practically all the principal cities have made installations; the most notable being London and Paris.

In 1909 the City Council of London sent a committee to the principal cities on the continent for the purpose of investigating the most improved street lighting systems. On its return, this committee recommended that London should adopt high pressure gas lighting on all streets where a high degree of illumination was required. As a result, the city of Westminster within the past few years has replaced practically all its electric arc lamps with high pressure gas lamps of 1,500 to 4,500 candle power. Regent Street, Piccadilly, Pall Mall, Kingsway and other principal thoroughfares are now abundantly yet economically gas lighted.

Paris, long known as the "City of Light," has adopted high pressure gas lighting for its principal squares and some of its boulevards. In time, lamps of 2,000 and 4,000 candle power will replace the low pressure gas lamps on all the important boulevards radiating from the Place de la Concorde.

Other cities throughout Europe are following the examples of the three important capitals and it is only a question of time before the general desire for better and more street lighting will invade this country.

As a modern illuminant, high pressure gas lighting will be one of the features of the Panama-Pacific Exposition. It is intended to use it extensively for the lighting of the main grounds and exclusively for the concessions. Also as a safe-guard against any possible failure of the electric supply, gas lamps will be distributed throughout the electrically lighted sections.

VOLUME, VELOCITY AND PRESSURE (DEPRESSION) METERS FOR GAS AND AIR

The annexed illustrations relate to the volume and velocity meter manufactured by Mr. Richard Cremer, York Place, Leeds, England, which has been designed for use in mines, steel-works, blast furnaces, gasworks, and, in fact, wherever measuring or registration of volume and velocity of large quantities of air and gas, traveling in pipes or channels, is to be carried out. It is, of course, an established fact that, considered independently, neither the draft pressure nor the volume, taken independently, can be regarded as reliable indication of the prevailing conditions in the fan drift or the main ventilating roads. If any reliance is to be placed on the records, both pressure and volume must be noted simultaneously. Normally, the static pressure will remain at the height corresponding with the area of the airways, and the volume of air supplied will, as far as possible, remain unchanged; both indications should therefore run fairly parallel so long as unexpected and unintended alterations in the ventilating system have not occurred.

If, for instance, a fall take place in one of the main ventilating roads, the static pressure will rise whilst the volume of air will be reduced. In the meter under notice, both these alterations are immediately recorded, one above the other, on the same chart. The appliance might also be usefully installed in upcast shafts to indicate the "false" air ab-

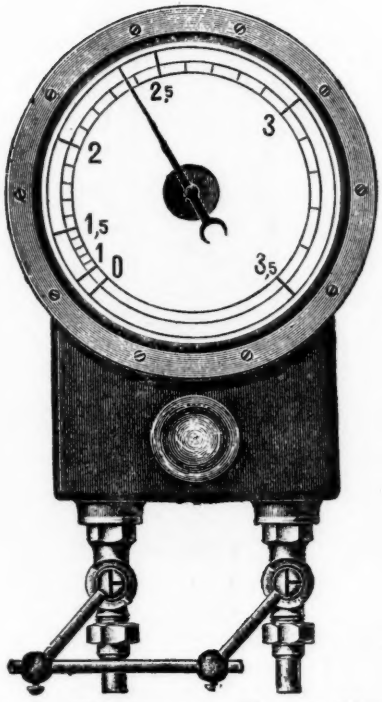


FIG 1.—VELOCITY AND VOLUME METER WITHOUT REGISTRATION

sorbed; thus, should the pressure fall with a constant or larger volume of air passing, it would be evident that too much "false" air was being sucked by the fan. The same would happen when, through any leaks in the airway, the amount of "false" air sucked increases. The meter then, with a larger volume, would indicate a smaller pressure.

The design of the apparatus permits it to be placed, within certain limits, at any distance from the place of measurement, and also allows the observation of various places by one apparatus by means of simply switching on or off the connecting pipes. The construction of the volume and velocity meter is shown in Fig. 3. As will be seen, a small baffle disc *s* is provided in the pipe *r* vertically to the direction of current. On each side of the disc close to its surface is a small tube conducting the pressure prevailing at the disc to the apparatus *a*. One of the tubes enters a float *g*, supported by a non-volatile oil in a cylinder *f*. The other tube enters the air-tight casing of the apparatus *a*. The float therefore acts under the difference of pressure prevailing on both sides of the baffle disc, its movements being transmitted as shown to the pointer of the indicator, and to the chart *w* in the glass cylinder *c* by means of a writing pen *h*. The apparatus is provided with a scale directly showing the velocity in feet per second, or in any other desired unit of velocity.

The construction of the combined volume (velocity) and pressure meter is shown in Fig. 4. A baffle disc *s* and a horizontal disc

FIG. 2.—COMBINED VOLUME, VELOCITY, AND PRESSURE METER, WITH REGISTRATION ON 3-IN. DRUM.

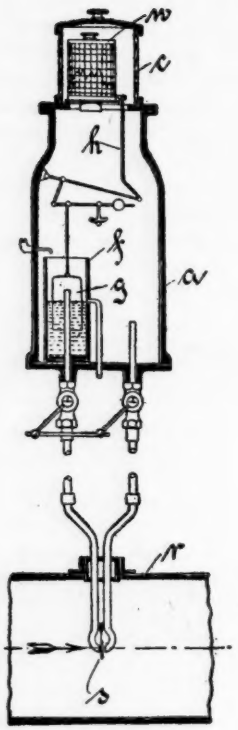


FIG. 3.

ss, are used in the measuring pipe in combination, the former being perpendicular to and the latter parallel with the air current. The velocity pressure acts upon the former, whilst the static pressure only influences the latter. Both discs are connected to the self-registering apparatus by twin pipes.

This apparatus contains in its air-tight casing *a* two floats *g* and g_1, working independently, to which the pressure acting on the discs is conveyed. The floats, which are supported in the vessels *f* and f_1, in non-volatile oil, transmit their movements to pointers or registration pens according to whether the apparatus is required with indicator or registration only or with both combined. The float chamber *g* is connected with the disc *s*, and the float chamber g_1 with the outer atmosphere, whilst the casing *a* communicates with the disc s_1. It will thus be noted that the static pressure prevailing in the pipe is reproduced in the casing *a*, whilst the pressure of the outer atmosphere is acting in the float g_1, and therefore the motion of the indicator will depend upon the pressure or depression in the pipe. The float *g* is acted upon by both the static pressure and the velocity pressure. The action on it therefore consists of the difference between the static pressure and the static pressure and velocity pressure, *i. e.*, the velocity pressure.— *Iron and Coal Trades Review.*

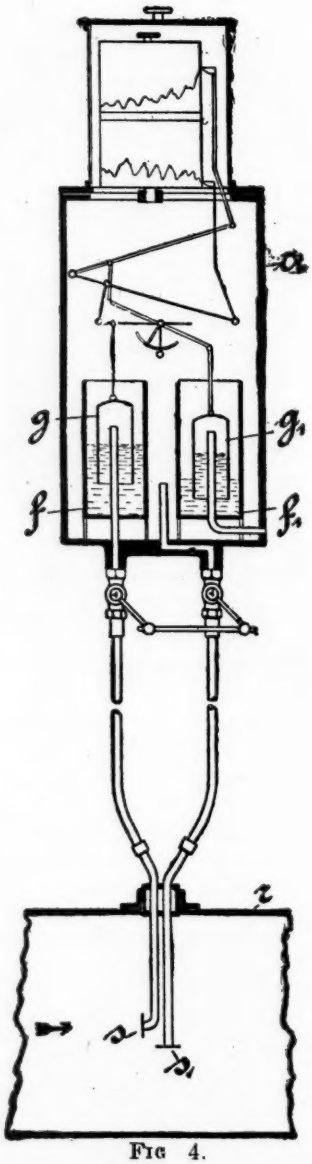
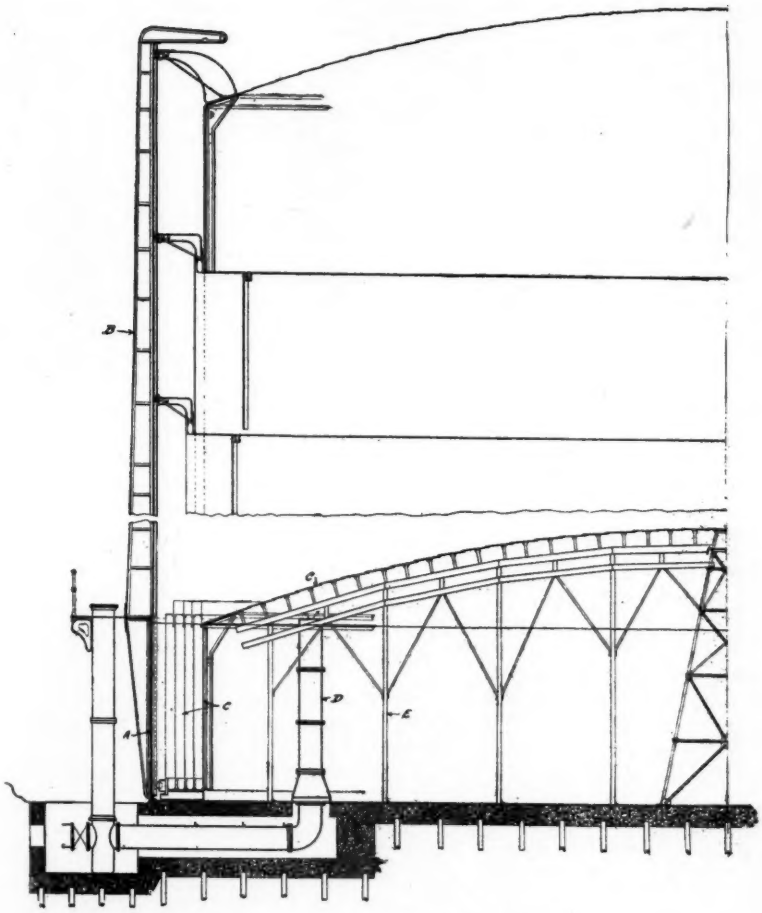


FIG 4.

At Akron, Ohio, a graduate of Stevens Institute recently made a pleasure trip in a balloon inflated with natural gas.



SECTION OF TELESCOPING GAS HOLDER.

A NEW GAS HOLDER HEATING SYSTEM

A most unavoidably familiar object to all the dwellers in civilized communities is the gas holder. It is so big and towering that it forces itself, and generally not welcomely, upon the sight of all. Few, however, whose attention has not been specifically directed to the matter, have any appreciation of the modern gas holder as a monumental achievement of engineering skill, which has involved the ingenious solution of a number of perplexing problems.

We here merely set out to call attention to the happy solution of one of the many details of gas holder design and management, but in the interest of the general reader it may be well to give a little sketchy account of the arrangement and operation of the modern telescoping gas holder.

When gas was first introduced in London the capacity of each single gas holder was limited by law to 6000 cu. ft. on account of the supposed danger. When the assurance of safety was reached the capacity limit disappeared. The holder then became a large circular pit filled with water and a large inverted cylindrical vessel whose sides dipped into the water became the gas receptacle, rising or falling as the stored volume of gas increased or diminished.

With the introduction of the telescoping principle the capacities of the holders increased enormously and the excavation feature was abandoned, it being so much easier and cheaper to dig upward into the air than

downward into earth or rock. Holders with capacities up to 6,000,000 cu. ft. are now quite common, while there is one of 12,000,000 cu. ft. at Rotherhithe, England, and one of 15,000,000 cu. ft. at Astoria, Long Island, opposite New York City.

Fig. 1 is a half sectional elevation of a telescoping gas holder which will help to an understanding of its construction and operation. The holder is assumed to be empty with all the lifts down, their tops being at about the same level as that of the outer shell or water tank. *A*, is the water tank; *B*, the guide frame; *C*, the holder; *D*, the main pipe used either as an inlet or outlet; *E*, the wooden crown support which saves the top from collapsing when pressure is entirely removed.

The gas is forced into the holder through pipe *D*, filling the space between the crown and the surface of the water, means being provided at first for the escape of the air. When the gas pressure becomes sufficient the first section of the holder begins to rise, and when it has risen to its full height what is practically a hook all around its lower edge engages with a similar internal hook at the top of the next section and then the two sections rise together. The second section lifts the third in the same way, and that in turn the fourth if there are so many. The entire top of the first section, being exposed to the gas pressure within, is a lifting surface, and this area being so great it is evident that the possible gas pressure in the holder must be very light, it being greatest when the holder is full and all the telescoping sections are supported by the pressure under the upper one.

The entire upper section is of course gas-tight in itself, but it is quite necessary to continue this gas-tightness from section to section, so that there shall be no appreciable leakage. This is accomplished, where the sections meet, by the water seal, an ingenious but essentially simple device. The external hook spoken of at the lower edge of each section, being continuous all around the shell, forms in fact a deep annular cup, and when each section rises from the water tank the cup is necessarily filled with water, and the inner lip of the next section projecting down into this cup and being submerged in the water the gas cannot pass it and escape.

That is, the gas cannot escape as long as the lip of the suspended section is below the surface of the water in the cup. The water, however, feels the gas pressure, being driven down on one side of the lip and rising correspondingly upon the other side, the difference in the height of the water upon the two sides adjusting itself with perfect accuracy according to the pressure, and at this point is determined the limit of pressure the holder can retain. The moment the water outside the submerged lip descends to the edge of the lip the gas will begin to escape at once, and that ends it. In the design of the holder the total weight of the lifts must be arranged in connection with the permissible submergence of the lip, so that the pressure required to lift the holder sections shall not be enough to drive the water quite down to the bottom of the lip, and as long as this does not occur the gas will not escape. The lower edge of the lower lift is a plain sheet, and when this is lifted out of the water the gas escapes and it is impossible for the holder to rise any higher.

As a matter of fact, the submerged internal lips spoken of do not come into actual contact with the bottoms of the cups, certain grips or lifters being provided to carry the weight, and water is free to flow as described from the outside to the inside of the submerged lip, or vice versa.

The gas holder is exposed not only to enormous wind pressures, which it must be braced to withstand, but also to changes of temperature, and this becomes serious when freezing begins, and has involved another difficult problem, as of course the freezing of the water seals must be prevented so that they may be perfectly free to act in releasing the sections when descending or in picking them up when ascending. It is also necessary to prevent the freezing of the water in the tank so that the holder sections may be free to move up and down. As long as only small holders composed of bell and tank were used, heating was a simple matter. Into the circular space between holder and bell, several steam ejectors were placed that absorbed the water, mixed it with steam, and gave it a circular motion, which prevented the formation of ice. When, however, the telescoped holders were used, this simple arrangement became impossible. To the holder heating is added the cup heating, which requires that the heating system should follow the upward and downward movements of the holder. Steam pipes, either rigid or flexible, must be used with

the use of roller guides and counterweights, and the result is much repairing and great maintenance costs due to the severe condition under which the heating system works. The quantity of steam used is considerable, for on the road from the lowest to the highest cup much heat is lost, so that it is never known whether enough steam is sent through the pipes. Another trouble lies in the fact that through the steam the cup water is always increased in quantity and the latter finally overflows and in severe weather freezes in large lumps on the outside of the holder. For a gas holder of say 200 ft. diameter and 160 ft. height another heating system would be desirable, and the Nürnberg gas works have used a new system for the last two winters.

The new system uses hot water instead of steam, the same working as follows: The hot water is mixed with the cup and holder water. Every cup is provided with a number of overflow pipes, which are conducted along the outside down to the next cup, and so down until the lowest pipes end at the surface of the tank. Now if hot water is forced into the upper cup by means of a pump, the water falls down from cup to cup, gradually losing its heat, till it reaches the tank. From there the overflow pipe takes the water back to the pump. The rigid mounted ascension pipe leads from the top of the tank to the highest position of the cup. From there a rubber hose, hanging free, communicates with the top cup. The hot water has to be conducted to the top cup, no matter what may be the position of the holder. The water flowing from the tank to the pump is heated by heating coils which are heated with steam. On the holder itself there are no apparatus that can go out of order. Since the heat losses in a hot water heating system are very low when compared to those in steam systems, the pump can stand at any distance from the holder—the distance in Vienna is 3,000 ft.—so that no special pumping room near the holder need be built.

The operation of such a system is very simple. One man is sufficient at the pump, who need not leaves his post at all, as he need only read the temperature of the water returning from the holder to know whether to increase the temperature or not. If there is not enough heat, in other words if the heating coils are not doing the work properly, he can see the trouble at once by watching the thermometer indicating the temperature of the water running to the cups. In a steam heating system he never knows whether enough steam is supplied, so that in this system the advantage lies in the greatest economy. If no steam is at disposal a hot water boiler can be used, directly fired. To judge the capacity, all that need be known is the number of heat units lost under severest conditions per hour in cups and tank; then the temperature and quantity of water can be determined without trouble. This system has been used during two winters in about six gas holders in various parts of Germany, one of these having a capacity of 250,000 cbm. (8,800,000 cu. ft.).

GASOLINE FROM NATURAL GAS

BY CHARLES T. HUTCHINSON.

It is doubtful when the idea of producing gasoline from natural gas originated. It has long been known that during cold weather a liquid collects in exposed pipes at many natural gas wells. At first the matter was regarded solely as a nuisance, since drip tanks had to be installed to separate the liquid from the gas, and when a considerable quantity of the liquid accumulated in the tanks they had to be emptied. That the liquid thus collected was gasoline was probably recognized by many persons, but for a period of several years there appears to have been no realization of the significance of the fact, and practically no attempt was made to utilize the product.

The pioneers in this development made arrangements with the lessees of a number of gas wells in the Pittsburgh district by which they were allowed to draw off the liquid from the drip tanks and dispose of it for a part of the profit realized. After going through a series of preliminary experiments it was found possible to prepare gasoline of excellent quality by simply compressing the natural gas in an ordinary air compressor and then passing the compressed gas through cooling coils connected to a suitable drip tank from which the separated gas could be drained off. Even with compression and cooling it is not possible to produce gasoline from natural gas which comes from the earth under high rock pressure, as such gas consists almost entirely of methane, and the natural pressure which exists in the earth has been sufficient to prevent its carrying any considerable amount of the heavier hydrocarbons.

Up to the last two years the general practice in the manufacture of liquid natural gas was to make the product by compression of the gas in single stage compressors operated at a pressure of 150 to 300 pounds per square inch. The one product thus obtained, so called "natural gasoline," was run into a tank and "weathered." The weathering consisted in allowing the lighter portions to volatilize spontaneously and escape into the open air, until such time as the boiling away of the liquid had practically ceased. The process thus involved a loss of 25 to 50 per cent. or more.

The next step in the industry was to pass the waste gases from the single stage compressor through one of higher stage, thereby getting a second and more volatile product which was run back into the first tank and mixed with the first or heavier condensate. This mixture was again weathered to a safe degree, whereby it lost the greater part of the more volatile product condensed in the second stage. Recently the process has been improved another step, in that the first stage compressor product is run into one tank and handled as ordinary gasoline; the second product into a separate tank and handled as a lighter gasoline with which the heavy refinery napthas can be enriched or enlivened.

The natural gas of this country frequently contains light products that do not condense in the second stage compressor, and for which it is practicable and necessary to use three stage, four stage, and even more stage compressors. These light products—true gases at ordinary temperatures and pressures—can be compressed and liquefied, but the liquid gases so obtained must be handled as gases and not as oils. The mistake heretofore made in the "natural gas gasoline" industry, as some have recognized, has been the attempt to handle the light gaseous products as oils and not as gases.

Until the manufacturers of this lightest, or three or four stage, compressor product recognize its gaseous nature, the absolute necessity for insuring the safety of the public involves certain restrictions in its transportation, and not until the realization that this extremely volatile liquid should be handled only in strong steel containers, capable of withstanding high pressures, will it be transported with safety.

The vapors accompanying natural gas are clean and are ready for compression. They are analogous to the manufactured products, but have the great advantage over the latter of being ready. However, they are at present in a great measure lost to the industries. The vapors should be compressed, as previously stated, but instead of being run into an open tank, or into a closed tank and weathered from it, with a corresponding loss, they should be run into steel containers and held there under compression. Such containers, capable of withstanding 3000 pounds pressure, may be procured from several firms. They may be transported to wherever gas of high heating or illuminating power is required.

One plant now in operation has a capacity of about 700,000 cubic feet of gas per day of 24 hours, and includes the following:

One two stage direct gas-engine-driven compressor, in which each stage operates independently of the other.

One intercooler, consisting of seven coils of 3 inch pipe with return bends, each coil 39 feet long.

One aftercooler, consisting of fourteen coils of 3 inch pipe, otherwise the same as the intercooler.

One small receiving tank which acts as a collector for the condensed gasoline.

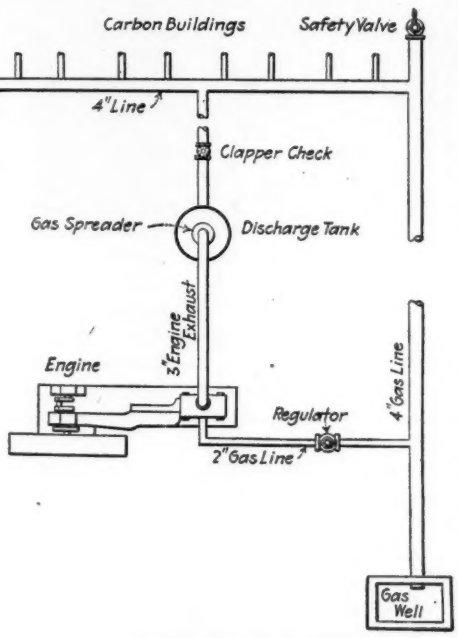
It will be noted that the high and the low pressure compressors are driven independently of each other. This is a desirable feature on account of the variable pressure at which gas is discharged from the well. Gas, after passing through a scrubber, is admitted to the low pressure compressor at or near atmospheric pressure, the temperature ranging between 60 and 65 degrees F. It is compressed to about 50 pounds, and a temperature of 190 degrees, at which it is discharged into the intercooler.

During its passage through the intercooler it is reduced to 45 pounds pressure and a temperature of 80 degrees, at which point it is taken into the high pressure cylinder and compressed to 250 pounds, the final temperature being 190 degrees. It then enters the aftercooler, in which the temperature is reduced to 60 degrees, the gasoline condensed being collected in the receiver and drawn off at intervals.

Both the intercooler and the aftercooler is arranged somewhat in the style of a cooling tower, and a spray of water is kept in circulation by means of a small pump, from the top of the cooler to a trough beneath, with baffles

arranged to give the maximum cooling effect.

An induction cooler is sometimes used for the final stage in the cooling process, before the gasoline is discharged into the receiver. This consists merely of a smaller pipe inside a larger one. A small amount of gas is permitted to expand inside the annular space between the larger and the smaller pipes, while the compressed gas, after passing through the aftercooler, is flowing through the smaller. The smaller pipe is generally two inches in diameter and the larger five inches.



NATURAL GAS DRIVES AN ENGINE.

INITIAL PRESSURE OF NATURAL GAS FOR POWER

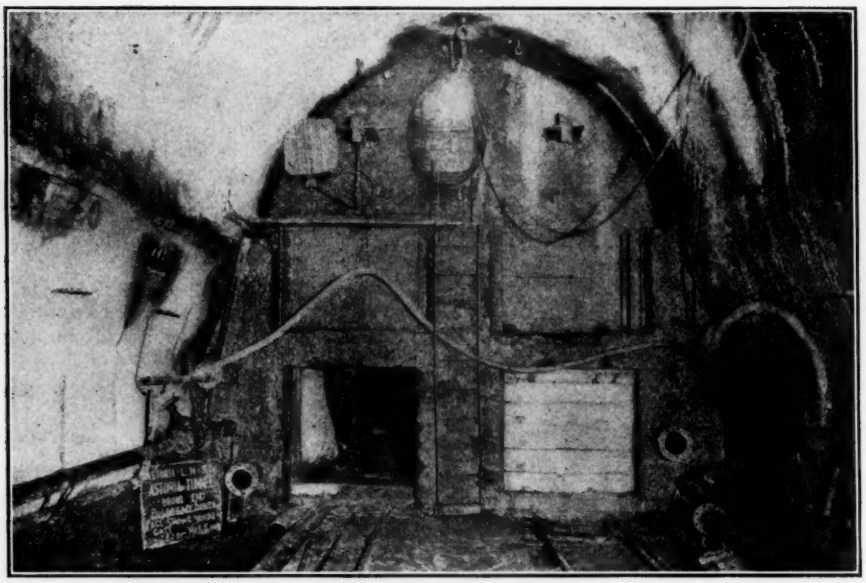
The plant of the Union Gas & Carbon Company, manufacturer of carbon black, is located at Wilsonburg, W. Va. Their product is obtained from the flame of natural gas by allowing it to impinge upon a smooth surface and then removing the deposit by traveling steel scrapers. The carbon black is used extensively in the manufacture of printing ink, paints, etc.

The natural gas emerges from a well 3,000 ft. deep at a pressure of 950 lb., which pressure was at first not utilized, the gas being led from the well through a 4 in. pipe direct to the burners, and the power required for the scrapers and other machinery being supplied by a steam engine.

Later the steam boiler has been dispensed with and the gas has taken the place of steam in the engine, which besides developing the required power, thus serves also as a reducing valve. The sketch, here reproduced from *Power*, shows the piping arrangement. A 2 in. branch was taken off the 4 in. gas main and led through a regulating valve to the engine. The exhaust is led into a discharge tank, a spreader being provided at the end of the exhaust pipe. From the discharge tank the gas passes through a 3-in. main to a clapper check valve, which works simultaneously with each chug of the exhaust and allows the gas to feed into the carbon buildings with constant regularity. By using gas in place of steam in this manner, the engine is said to respond quicker and more uniformly. It also, not only provides free power, but reduces the labor by one man.

AIR HOSE

Armored hose is well intended, but it cannot be considered much of a success. In mine use it soon becomes badly distorted either by short kinking or by being crushed, and, though the fabric may be still intact, the air friction passing the strictures is soon excessive. A dent, once occurring, can hardly be straightened out again. Furthermore, to cut and patch the hose in such case, or if it be punctured, is a vexatious job, as the wire winding gives trouble. Better satisfaction has been found by the adoption of a hose similar to that used for air couplings on railroad trains, with a heavy fabric to stand the pressure and a thick protection of rubber on the outside. Such hose is not injured by short kinking nor is a stricture formed by rock falling on it, and should it be cut by a blast it can be quickly mended. A length of this was coupled to a length of armored hose and put in service in the South Mine opencut, at Franklin Furnace, in February, 1908. It remained in continuous service until September, 1912, while the armored hose connected with it had to be renewed every few months. In fact it outwore so many lengths of the latter that count was lost. The material broken here was not particularly hard and sharp, and it is possible that in a quartzose mine the wear on rubber might be so excessive as to make armoring advisable.



SAFETY BULKHEAD IN ASTORIA GAS TUNNEL.

THE ASTORIA GAS TUNNEL

A large tunnel for the transmission of artificial gas from Astoria, Long Island, to the Borough of the Bronx, all within the limits of Greater New York, which tunnel has been under way for two or three years without much mention in the public prints, was "holed through" on July 17 and will soon be ready for service.

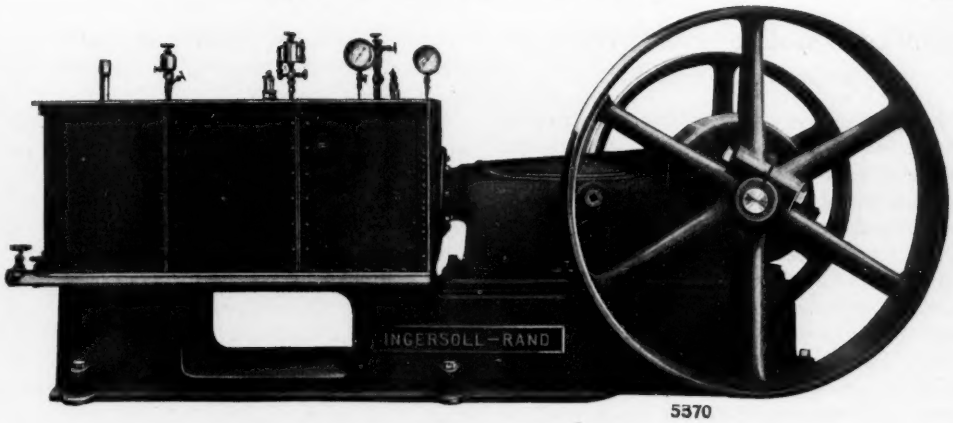
The tunnel has a D section, the flat side of the D forming the base of the tunnel. It is 19 ft. 9 in. wide, 21 ft. high and 4662 ft. long. It will at first carry two gas pipes 6 ft. dia., with ample room for two more as they may be required. The mean depth of the tunnel floor below the river surface is 246 ft., it being expected that at this depth solid rock would be found, and that the tunnel could be driven under constant exposure to the atmosphere, the depth was such that the pneumatic process of driving was not possible.

The tunnel was driven from two vertical shafts, the Astoria shaft being 34 ft. 6 in. in diameter and 277 ft. deep, while the Bronx shaft has a diameter of 26 ft. and a depth of 233 ft. The concrete lining of the tunnel varies in thickness from 18 in. to 36 in. and in some places is reinforced with steel rods.

After the headings had been turned the tunneling proceeded without difficulty for 750 ft. from the New York side, when a large inflow of water was encountered and work at that end was suspended. The heading from Astoria was advanced 3500 ft., or to within about 400 ft. of the Bronx heading when the bad ground was again encountered. There were fissures of disintegrated material with water under full head, and in some places large pockets were uncovered.

Pilot holes had to be drilled in advance of the heading which were plugged with valved pipes and where the leakage was high these were grouted under great pressure. Concrete bulkheads also were built at intervals across the tunnel sections and were fitted with quick closing gates at the bottom and man locks at the top to prevent the flooding of the whole tube and to allow the workers to escape in case of a sudden inrush of water. Cast iron ring lining was used in this section. The 400 ft. of ground of this character took as much time and probably cost more than all the rest of the tunnel.

In putting in the concrete lining the ground water was drained away by pipes passing through the forms. These pipes are now being used to carry grout into the open spaces behind the lining and thereby cut off the leakage. Ingersol-Rand compressors and rock drills were employed for the work.



THREE STAGE COMPRESSOR FOR ACETYLENE.

COMPRESSION AND TRANSPORTATION OF ACETYLENE

BY R. H. CUNNINGHAM, JR.

Acetylene gas is to-day used very extensively for automobile headlights, and while the gas can be generated from the carbide just as it is burned, the operation is not without its troubles, and this has led the Prest-o-lite Company of Indianapolis to develop a commercial proposition whereby the autoist can be provided with portable tanks of acetylene gas.

It has taken years of practical experimenting and testing to prove all the queer characteristics of this gas, and the charging of the tanks has made a nice and delicate problem for the compressor people. At present a three stage compressor is used, charging the tanks at a pressure of 275 lb. Very slow speeds and the most reliable and effective intercooling and aftercooling are required as compared with ordinary air compressor practice. The heat of compression causes the gas to separate into its component elements which are ready to combine again at higher temperatures and cause a disastrous explosion.

The tank used for transportation is made of cold drawn steel. The tank is filled with bricks of asbestos, which material has a porosity of about 80%. An acetone, which has a great affinity for acetylene, is put into the tank and, due to this affinity, from fourteen to sixteen times as much gas can be put into the tank as it would hold without the acetone. The asbestos brick forms a sort of cell arrangement which allows the several cells to discharge in succession rather than simultaneously.

The Ingersoll-Rand Company have built a special compressor for acetylene, and the machine has been carefully designed so that its work may be done most safely and efficiently, every emergency which can be anticipated having been provided for.

The three compressing cylinders are entirely submerged in a sheet iron water box, which also contains the pipes for intercooling between the successive stages. The piston rod gland is covered with water so as to reveal any leak of gas from the second stage of the compressor. The operator can detect any leak at a glance and can easily remove the iron box for purposes of repair or adjustment, so that one man can easily take care of a charging station.

The Prest-o-lite Company have several of these charging stations in the United States and Canada, having placed five compressors already this year, with five more to be installed before the spring rush of business.

This means of auto lighting, for lighting harbor or channel buoys, for acetylene welding and the like, has developed a wonderful business, and the distribution of these ready charged gas tanks throughout the country is now so well taken care of and the use and application is so simple that most people prefer to get a tank and apply it to whatever they may have to do with it.

The use of acetylene for auto lighting and auto starting grows constantly in spite of the present popularity of the electric starter and electric lighting devices, which have their good points but also their drawbacks.

PRODUCING GASOLINE FROM NATURAL GAS

BY FRANK P. PETERSON.

In 1911 the world's yield of crude petroleum is believed to have been about 320,696,316 bbl. While difficult to say just how this was split up into the various commercial forms, it is safe to say that not less than 10 per cent., or over 32,000,000 bbl., was used in the form of gasoline. This is notable in contrast to the fact that 20 years ago there was no appreciable demand for gasoline.

An important step in the production of gasoline has materialized during the past 2½ years in the form of stripping waste gases of suspended heavy hydrocarbon vapors and using these condensates as gasoline.

Theoretically, the process of recovery is very simple, namely, the application of pressure and cooling of the gas, provision being made for separating the condensates by precipitation under pressure.

Nearly all the oil wells yield some gas; many yield great volumes while others yield gas only from the strata in which the oil is produced. Again, some yield one gas from their oil strata and another gas from other strata through which the well passes and which is not "cased off."

The gases which issue from "dry" or non-oil-producing strata are often largely pure methane (marsh gas CH_4), which has a critical temperature of 115 degrees F., and will not condense at any pressure above that temperature.

The gases which reside in the strata along with the oil, however, are in contact with the oil in a finely divided state in the interstices of the sand. There is every opportunity for the methane gas, when issuing from the strata at low pressure along with the oil to pick up and carry in suspension any vaporous oil. Further than this, it is now known that the whole family of saturated hyrocarbons are found together right through the series from CH_4 to a heavy wax structure. This complicates matters, for there are many gases that have and many that have not sufficient suspended heavy compounds to yield paying quantities of gasoline condensates. Hexane (C_6 H_{14}), petane (C_5 H_{12}) and butane (C_4 H_{10}) are the factors which, when present in sufficient quantity, warrant reduction to a liquid state for market. Hence, the prevalence of these condensible constituents must be determined before attempting to compress the gas for their recovery.

One of the first steps is to find the specific gravity of the gas, although this cannot be depended upon entirely. For instance, family A, from one well or group of wells might consist of 10 per cent. methane, 30 per cent. ethane, 30 per cent. propane and 30 per cent. butane. The specific gravity would be about 1.43 (air = 1), and nothing could be produced from it marketable as gasoline.

Family B, from another well or group of wells, might consist of 60 per cent. methane, 5 per cent. ethane, 5 per cent. propane, 5 per cent. butane, 10 per cent. pentane and 15 per cent. hexane, in which case its specific gravity would be 1.26 and the 25 per cent. comprising the two heaviest constituents would yield a gasoline condensate, marketable as gasoline of at least 9 gal. per 1000 cu.ft. of gas.

The condensates yielded by the different gases are classified commercially into two general groups: natural gas gasoline and gasol. The first is the unrefined bulk of condensate as it is recovered from the gas and the second is the refined compounds derived by splitting the condensates into groups for different uses.

John Lathrop Gray secured the first broad patents relating to the production of gasoline from natural gas, and the writer, perceiving the need for further refinements, deviated from Gray's constant-pressure, constant-volume method by breaking the operation into steps for the purpose of drawing off fractions differing in specific gravity and boiling points. More recently, however, Dr. Snelling has added what appears to be the final touch of refinement which respects both the critical pressure and temperature characteristics of different compounds and enables the greatest nicety to be realized in the fractionation of the complex gaseous compounds into their several liquid states. It is needless to add that the gasol fractions must be retained and handled under restraint of considerable pressure when they approximate propane and the lighter compounds.

An important phase of the recovery of gasoline from natural gas is that separation is effected under physical conditions maintaining a close equilibrium between the liquid and the gaseous states. Because of its lightness as

compared to the mediums ordinarily handled by baffling and trapping, much difficulty has been experienced in eliminating uncertainties in the operations; hence, a vast amount of "cut and try" application.

Physically the product in appearance is white. It carries, usually, a very small (negligible) percentage of heavier oils, sometimes lubricant from the compressor cylinders. In time it evaporates to complete dryness comparable to and usually quicker than a refined oil product of equal heaviness. Its specific gravity varies widely, in different regions and with different pressures applied to obtain it, ranging from 0.625 to 0.71 (water = 1), or from 96 to 68 deg. Braumé.

As a fuel for gasoline motors its carburetting qualities are excellent. Consequently, the impression has become more or less general that its power value is much greater than ordinary refined gasoline. This is not true, except in the sense as the hydrogen ratio of a fuel increases, so does its gross fuel value.

Refined stocks, because much less volatile, can be stored without loss, while the new product cannot, even in winter, be stored in open tanks without loss. As fuel for light gravity gas lighting machines it is good, but its most fitting place seems to be in mixture with the refiners' low gravity gasoline or naptha fractions whereby a motor fuel of maximum power and the best carburetting characteristics may be had.

Many instances have already occurred in which the abandonment of a few small oil wells in oil fields has been saved by the installation of equipment to recover gasoline from their heretofore wasted gases. And it is not unusual for such wells to yield a greater amount of gasoline condensates than they do of crude oil. And as the condensates have a value at the well of about twice that of the oil, it can readily be seen how great a boon it is to the small oil operator whose revenue cannot be maintained sufficient for livelihood from the oil alone. The present production is about 2500 gal. per day.

What is claimed to be the largest steam turbine in existence is being constructed by Messrs. Brown, Boveri & Co., of Mannheim. It is a 35,000-hp. unit and will be coupled to a generator.

COMPRESSED AIR HUMIDITY PROBLEM

BY FRANK RICHARDS.

The following has to do with a case in which compressed air was used for blowing out electric generators, with the not unfamiliar result that the air jet delivered also more or less water, and the question arose as to how to be able to deliver dry air. It had been suggested that a change in the piping leading into and out of the air receiver would have provided the necessary relief, but it is here contended that much more than this was required.

To begin with, there is practically no such thing as dry air. So far as the water nuisance in compressed air practice is concerned, it generally makes little actual difference where the air is taken from, as all atmospheric air, free air, carries moisture, and when air is sufficiently compressed it has more moisture than it can carry, and then the released water becomes a nuisance or worse, as in the case under consideration. The problem is to get rid of the surplus moisture before it can cause trouble, and the conditions of air compression and transmission generally furnish the opportunity, however little it may heretofore have been availed of.

In the daily meteorological reports in the papers the humidity of the air is one of the most important items, and it shows a much wider range of fluctuation and more rapid changes than either the temperature or the barometric pressure, which suggests what an active business is done by the atmosphere in the water carrying line.

The capacity of air for moisture, up to the point of saturation, depends upon both its volume and its temperature. If the volume of any given quantity of air is reduced by compression, or increase of pressure, its capacity for moisture will be reduced in almost direct proportion. With a reported humidity of 50 per cent. for atmospheric air, which is not far from the average in many localities, if the air were compressed to 2 atmospheres, or say 15 lb., gage, then it would be saturated, or the humidity would be 100 per cent., or the air would have all the moisture it could carry in the form of intimately commingled vapor.

If the same air were compressed to 4 atmospheres, or say 45 lb., gage, then one-half of the moisture in it at the beginning would

immediately cease to be true vapor and would be condensed into real water, although it would still be distributed through the air in minute globules. If during the operations here suggested this air were enclosed in glass it would be seen to be perfectly transparent until the point of saturation was reached, and after that the condensed moisture would give it a misty or foggy appearance. This released water still in the air would wet anything with which it came in contact, and if the air was stationary or moving slowly in large pipes the water would gradually settle down through the air and be deposited along the bottom surface of whatever it was contained in.

For the air and its load of moisture to act as here described we have had to assume one impossible condition. We have ignored the fact that the compressing of the air always raises its temperature, and that the changing temperature of the air has more to do with its moisture carrying capacity than has the reduction of its volume. The hotter the air is the greater is its capacity for aqueous vapor, and the raising of the temperature of the air by the operation of compressing it increases its moisture carrying capacity more rapidly than the reduction of volume reduces that capacity, and the actual compression brings the air to the end of the operation sensibly dryer instead of wetter than at the beginning, although the actual water content has not been changed.

The moment, however, that the compressed air has been delivered by the compressor into the pipes or receiver its moisture capacity begins to change rapidly, because the temperature of the air falls at once. Unless the air is used immediately after it is compressed, and very near the compressor, its heat of compression is all dissipated, its temperature falls to that of its surroundings, and both the conditions of reduced volume and reduced temperature are combined in their effect to reduce to the minimum the vapor carrying capacity of the air and to set free a large portion of the water it contained when the compression began. The air will then inevitably be more than saturated with vapor and will contain actual water all through it, and it can only be described as very wet air.

If this air, without anything being done to it, is used for almost any mechanical purpose the water will make itself manifest, and almost invariably in a more or less undesirable way, but if while the air is at its highest pressure and its lowest temperature the air is drained of its entrained water by passing through a separator—a steam separator of any of the usual types does the work very well—then the water will not be heard from later. If the air under full pressure is transmitted through pipes for a considerable distance the water will drop out of it and flow along the bottom of the pipe, and if this water is not drawn off from pockets which should be provided, then in the final rush of the air as it leaves the pipe to do its work the water will be picked up and carried along and will be just as bad as if it had never been deposited by the air at all. The actual separating and drawing off of the water after it has been released by the super-saturated air is a point which has been too frequently neglected.—*Practical Engineer.*

FOR THE COMPRESSIVE VENTILATION OF MINES

Rees H. Beddow, State Mine Inspector of New Mexico, writes in *Coal Age* of the advantages of the compressive system as compared with the exhaust system of mine ventilation. In the former system, he says, where the air is driven into the mine instead of being drawn out, the mine is ventilated under a pressure greater than that of the atmosphere, while in the exhaustive system of ventilation, the mine is ventilated under a pressure less than that of the atmosphere. To make this matter more clear, assume the atmospheric pressure (sea level) is 14.7 lb. per sq. in. or 2116.8 lb. per sq. ft. If the mine water-gage taken in the fan drift is 2 in., the ventilating pressure is 2x5.2 = 10.4 lb. per sq. ft., at this point. Then, assuming the efficiency of the fan is 60 per cent., the total pressure producing ventilation or circulating the air through the fan and the mine is 10.4 ÷ 0.60 = 17.3 lb. per sq. ft.

When the fan is blowing the air through the mine (compressive system) the total pressure on the intake air is 2116.8 + 17.3 = 2134.1 lb. per sq. ft. On the other hand, when the fan is exhausting the air from the mine, the pressure on the intake is the atmospheric pressure (2116.8 lb. per sq. ft.) and the pres-

sure on the air in the fan drift (return airway) is 2116.8 — 17.3 = 2099.5 lb. per sq. ft. This shows a difference in the mine pressure, in the two cases, of 34.6 lb. per sq. ft., in favor of the compressive system. In my judgment, this difference in pressure is exerted to keep back much of the poisonous and inflammable gases that would otherwise enter the mine, and is one point in favor of the compressive system of ventilation.

FAST WORK IN A MINE DRIFT

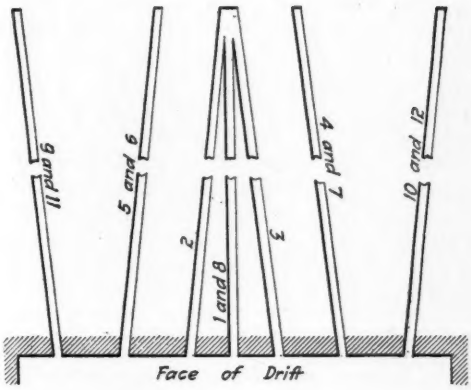
BY E. T. LEDNUM.

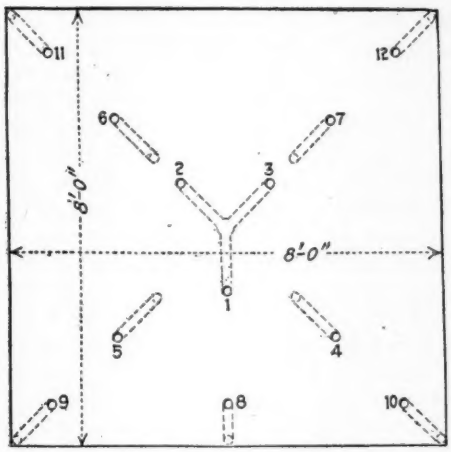
On Feb. 1, 1913, the Vinegar Hill Zinc Co completed a double-track tramming drift at the Ellsworth Mine, near Livingston, Wis. (in the lead and zinc district). The drift is 8 ft. high and 8 ft. wide, and 391 ft. in length and was driven in 57 shifts of 9 hours each. The total time consumed was 37½ days. Part of the time drilling was carried on during each shift but during the latter part of the work drilling and blasting were done on the night shift only and the muck was removed during the day shift. The drift was in the oil-rock formation of Galena limestone.

A part of the drift was driven by drilling but seven holes; three cut holes near the bottom in the middle of the heading, drilled to meet at the points; two bottom corner lifter holes, and two upper corner holes. In mineralized ground twelve holes were drilled, and the arrangement of these holes is shown in the accompanying cut. The cut holes Nos. 1, 2 and 3 were drilled to meet at the points and were, of course, fired first. The average advance per shift was 6.85 ft. The average advance per day was 10.4 ft.

One No. 8 Leyner drill was used, and all holes were drilled 12 ft. deep. The total amount of powder used was 6930 cartridges (1¼x8-in.) of du Pont forcite gelatin and duPont low-freezing gelatin of 40 per cent. strength. The powder was exploded with Metallic Cap Mfg. Co. and du Pont No. 6 caps; 1012 caps were used and 7613 ft. of Climax-Crescent fuse.

During January the temperature dropped below zero, but at no time did the mining company find it necessary to thaw the duPont new low-freezing gelatin in the thawing magazine. The powder was taken from the storage magazine into the mine at the beginning





LAYOUT OF DRILL HOLES.

of the shift and when drilling was finished the powder was ready for use. It was necessary to install a blower, and there was no ventilation. The work was under the direct supervision of Goodsell Billings, Superintendent — *Engineering News.*

CYANAMID AS A FERTILIZER

Nitrogen is the most important of the plant foods. It is usually the first element to become deficient in cultivated soils, yet when good forms and proper amounts are furnished, crops respond to it with a more direct and immediate effect than to applications of phosphate and potash. All the combined nitrogen now in existence on the earth's surface came from the atmosphere at some time or other. Previous to the discovery of Cyanamid the only practical means of fixing atmospheric nitrogen was by the action of bacteria. These

bacteria, themselves living on plants or plant refuse, take nitrogen from the air and combine it into chemical forms that plants can absorb. If plants were not removed, but were left to decay where they grow, the fertility of the soil would probably never decrease. When crops are removed, however, not only is the nitrogen carried away, but also the plant matter on which the bacteria feed. Then, in order to maintain fertility, it is necessary to restore combined nitrogen to the soil from other sources.

DISCOVERY OF CYANAMID.

The problem of artificially fixing atmospheric nitrogen into combined forms suitable for plant food has been investigated for a great many years, but not until 1895 was an adequate process discovered. In that year two German scientists, Drs. Frank and Caro found that when nitrogen from the air is conducted through a white-hot mass of calcium carbide (the material in common use for generating acetyline gas) there is produced a compound, known as Cyanamid, very rich in nitrogen. This form of combined nitrogen was found to possess particular value as fertilizer, and its use for this purpose has developed an enormous industry. Cyanamid factories have been established all over the world. One of the largest is located at Niagara Falls, where large quantities of electricity, required by the industry can be obtained at low cost. There are also four Cyanamid factories in Germany, two in France, and one each in Austria, Italy, Switzerland, Norway, Sweden, Japan and India.

Cyanamid is a dark-gray, odorless, dustless, granular material. It contains from 18 to 20 per cent ammonia, about 12 per cent. carbon, or lamp-black, and the equivalent of about 70 pounds of slaked lime. The material is shipped in regular fertilizer bags and can be stored indefinitely.

Cyanamid nitrogen is readily soluble. Ninety-six per cent. will dissolve out in cold water in twenty-four hours, and is, therefore, available as plant food. On contact with the soil it reacts quickly and forms first the organic compound, Urea (which is also contained in Peruvian Guano and Barnyard Manure), and then changes into the form of double ammonium compounds. These compounds are not leached or washed out of the soil, but are made available to crops by bacterial action and the solvent effect of plant roots. This action insures a slow, steady supply of nitrogen that has the advantage of not overfeeding crops a few weeks and then starving them, but of supplying this element throughout their principal period of growth. Since the soil duration of Cyanamid nitrogen is from 60 to 80 days, crops are not fed when they should be maturing, and, therefore, ripen earlier and more uniformly.

OZONE—ALLOTROPY

If a current of oxygen is subjected to the action of a very high voltage oscillating discharge of electricity (several thousand volts) a part of the gas is converted into another substance, ozone. The physical properties of ozone are altogether different from those of oxygen. It has a peculiar odor, similar to that often noticed in the neighborhood of electrical machinery, and frequently observed after a thunder storm.

The density of ozone is 3/2 that of oxygen, if both gases are measured under the same conditions. Ozone boils at a temperature of —110° C. (—166 F.), the liquid possessing a cornflower blue color. Liquid ozone is explosive, passing into ordinary oxygen with the liberation of a large amount of heat.

The relation between oxygen and ozone is a peculiar one, and both substances are said to be allotropic modifications of one element. While the physical properties are different, oxygen and ozone can be converted quantitatively into one another. The energy content of ozone is greater than that of oxygen. Also, oxygen and ozone react with the same substances, in the same proportions by weight to produce exactly the same substances. It is true that ozone, perhaps on account of its greater energy content, reacts more vigorously with certain substances than oxygen does. For example, silver is readily converted into its oxide by ozone, but only very slowly indeed by oxygen. But the oxide formed is the same in both cases.

Advantage is taken of the greater chemical reactivity of ozone, and it is now being extensively used for disinfecting purposes in hospitals, for freeing water from harmful bacteria, for sterilizing air in breweries and for purifying air in public buildings and subways, for preserving foodstuffs in cold storage, and for bleaching feathers, silk, wool and even cotton and linen.

HOW GOOD BRAKES SHORTEN THE RUNNING TIME

In 1907 the capacity of the Subway in New York was under consideration, and of course an effort was made to increase it. At that time it was increased by improving the brake. Strange as it may seem, they got over the road quicker by using better brakes and I believe at that time it was the only change that was made, and the capacity was increased very materially. In 1910 they were considering putting on larger motors in order to get sixty miles an hour instead of forty, and therefore get over the road in shorter time.

That looks perfectly natural, and yet under those conditions they would have actually consumed more time between stations than with conditions as they were. The reason for that is that when you double the speed of a train it takes four times the distance to stop, and in this case it would require more than twice the distance to stop; consequently, in such short runs as they have they would have made no material gain by using larger motors. Then it was suggested that they put on better brakes and stop sooner or in shorter distances. At first glance it didn't seem as though they could make much increase of capacity from this, but when it was pointed out that time saved by deceleration has a value equal to that saved by acceleration, and that a much more rapid rate of deceleration was obtainable, the possibility of increased capacity was apparent.

By a full use of the potentiality of the rail, practically all the power developed in the electric plants of New York and put into these trains, could be used to much better advantage. Nearly all of the amount which was waste product could, by making more efficient stops, be made into a by-product and therefore make a large gain to the railway company.

This is how it was done. The train possesses a certain energy. That energy can be dissipated in minutes or in seconds at the will of those in charge. If you dissipate it in seconds, it is obvious that you shorten your stop; in minutes, why, you consume that very element which the railway is built to save, namely, time. With better brakes a train with the old brakes on and one with the new could leave a station together and with the cars equipped alike for power (a maximum of forty miles an hour) at the point where the old type had to apply its brakes the other one could continue to move under power for some distance, and thus the train with the new brake would be in the station to which it was going and its passengers discharged, other passengers on the train and clear, when the train with the old type reached the stopping place. This was done, and the time of stopping was cut down to one-half of that previously required. Thus the one train was moving with the power on for 20 seconds after the other had the brake on. Also the emergency stop was cut from 650 to 350 feet, so that the signal space could be shortened, and together the capacity of the subway was increased about 40 per cent. per day. This shows what can be done with the brake. It cost some money to do this, but not one-twentieth of what it would have cost to have obtained the same result by other means.

*Walter V. Turner, before Railway Club of Pittsburg.

ANALYSIS OF EXPLOSIVES

The Analysis of Black Powder and Dynamite, is the title of Bulletin No. 51 recently issued by the United States Bureau of Mines.

This bulletin outlines the methods of analysis that are used in the examination of certain classes of explosives. The present form of most of these methods has been worked out in the bureau's explosives laboratory. The methods employed by Prof. C. E. Munroe were taken as a basis, and were elaborated to meet the demands incident to the treatment of complicated mixtures and to the development of the explosives art. This bulletin presents the methods of analysis of "Ordinary" dynamite, and the ammonia, gelatin, low-freezing, and granular dynamites, and the common grades of black gunpowder and black blasting powder. The bulletin is published by the bureau for the information of all persons interested in explosives and their safe and efficient use in mining work.

As the term "ordinary" dynamite, though much used, has no conventional meaning, and may be used to cover a wide variety of compositions of matter, it may be noted that the standard dynamite used at the Pittsburgh testing station is a good example of the "ordinary" dynamite known in this country. This

testing station dynamite has the following composition:

COMPOSITION OF PITTSBURGH TESTING STATION DYNAMITE.

	Per cent.
Nitroglycerin	40
Sodium nitrate	44
Wood pulp	15
Calcium carbonate	1

As most permissible explosives contain only the constituents found generally in the various types of ordinary dynamite, the chemist will usually find it possible to analyze such explosives either wholly or partly by following the general methods of analysis given in the bulletin for the type of explosive that seems most closely related to the one under examination. The methods of extraction with ether, with water, etc., outlined in the bulletin are general methods which are applied with equal success to all classes of explosives, and therefore by the use of these general methods, following a thorough qualitative examination, little difficulty should be met, except with those classes of permissible explosives that contain large amounts of salts holding water of crystallization, such as alum and magnesium sulphate, or those containing an unusual number of uncommon constituents. Even with such explosives, however, if the information desired is principally in regard to the percentages of explosive ingredients (nitroglycerin, ammonium, nitrate, etc.), the methods outlined in this bulletin may be satisfactorily followed.

WORKING CONDITIONS FOR MINERS.

There is always something happening to the air in a mine. In one way or another the oxygen is being absorbed, carbonic acid gas is being formed, and other bad gases are being generated. The breathing of the working men, the combustion of illuminants, and the exhalations from the veins and underground crevices all play their share. The miners' lamps or candles show the loss and decrease of oxygen by growing dim. If the oxygen falls even from 20 to 18, the ordinary lamp or candle will go out, and the workers grow blue in the face and sigh, yawn, and breathe irregularly. When this happens the working efficiency of the miners will be seen to fall off as much as from 50 to 100 per cent. Weakness of arms and legs may occur and even fainting and loss of consciousness. Some men grow excited, sing, shout, and become rash and careless and fail to observe ordinary caution, not realizing the danger they are in. With increase of heat in the mines there is additional danger. Evaporation, radiation and sweating help to keep this down. By drinking lots of cold water miners are able to combat this heat and keep up their efficiency.

LARGE RECIPROCATING COMPRESSORS

The following dimensions and other particulars are given out concerning compressors furnished by Reed Meyer, of Mulheim on the Ruhr (Prussia), for mines on the Rand, South Africa:

Diameter of steam cylinders	31 & 62 in.
Diameter of air cylinders	54 & 33 in.
Common stroke	50 in.
Speed	65 to 72 r.p.m.
Free air intake per hr.	565,000 to 644,500 cu. ft.
Total weight	176 tons
Diameter of flywheel	21.8 ft.
Face of flywheel	26 in.
Total floor space	1,560 sq. ft.
Normal duty	1,700 to 1,750 hp.
Widths of air-cylinder pistons.	52.75 and 44 in.
Diameters of air nozzles	
High-pressure side	17 in.
Low-pressure side	28 in.

The steam cylinders have the Doerfel positive valve-gear; the air cylinders Meyer disk valves for high rotative speeds. The steam end is run condensing and its cylinders are jacketed with live steam. The machine is unprovided with tail rods and guides, notwithstanding the long stroke rendered unnecessary by the construction of the air pistons.

The acceptance test showed the following results: Mechanical efficiency, 89.25 per cent.; volumetric efficiency, 98.7 per cent.; steam consumption, 11.28 lb. per i.hp.-hr. at a pressure of 172 lb., a temperature of 482 deg. F. and a vacuum of 25 in.; air temperature at a pressure of 89.5 lb. behind the low-pressure cylinder, 203 deg. F.; behind the high-pressure cylinder, 196 deg.; showing an advantageous working of the intercooler.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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CONTENTS

High Pressure Gas in British Shops.... 6939
Explosion of Natural Gas..... 6942
High Pressure Gas for City Lighting.. 6943
Meters for Gas and Air..... 6944
New Gas Holder Heating System..... 6947
Gasoline from Natural Gas..... 6949
Pressure of Natural Gas for Power.... 6951
Air Hose..... 6951
The Astoria Gas Tunnel..... 6952
Compression and Transportation of Acetylene 6953
Producing Gasoline from Natural Gas 6954
Compressed Air—Humidity Problem... 6955
For Compressive Ventilation of Mines. 6956
Fast Work in a Mine Drift..... 6957
Cyanamid as a Fertilizer..... 6957
Ozone—Allotropy 6958
Good Brakes Shorten Running Time.. 6959
Analysis of Explosives..... 6959
Working Conditions for Miners..... 6960
Large Reciprocating Compressors..... 6960
The Growing Business of the Compressor 6961
Ingersoll-Rand Products 6962
Compressed Air Auto Starters..... 6963
Notes 6965
Patents 6966

THE GROWING BUSINESS OF THE AIR COMPRESSOR

We have in mind here the business, or the scope of employment, not of the compressor builder, but of the compressor itself, although quite naturally the one must keep pace with the other. Ever since the air compressor became a commercial product the rate of its production and the reach of its employment have had a race with each other to keep in touch with the opportunities, or, as we generally say it, the demands abreast and ahead.

In looking even casually and carelessly over the compressed air field, or say only through the pages of the present issue of COMPRESSED AIR MAGAZINE, one can scarcely fail to be impressed with the number and magnitude of the demands—actual demands—which are constantly being made upon the compressor as the only adequate means to satisfy them.

In the normal compressed air field the work increases along the established lines without let up. Not only do the mining, tunneling, caisson sinking, rock drilling, and such primitive customers of the air compressor grow with everything else, but practically all industries have now their special uses for compressed air, and an air compressor is a part of the installation of every power plant of any size.

But the air compressor is now much more than a compressor of air. It deals with all elastic fluids with equal facility, and it may yet come to be known generically, rather as a gas compressor.

Natural gas when it was first struck and made itself the talk of the world was quite independent of the compressor, having pressure enough to send it beyond the longest distances then contemplated for transmission, and new wells still coming into service have their inital surplus of pressure. This, however, soon changes when the well pressures fall and the pipes are extended, and there are already a great number of compressors of large capacity in the natural gas business.

Great numbers of compressors are already employed in the compression and transmission of artificial gas, but in this field we may expect to see an enormous increase of such employment. It is apparently inevitable that the example of high pressue natural gas transmission will be followed also by the artificial gas companies, and the growing demand of con-

sumers everywhere for pressures higher than those which are possible with the too familiar gas holder promises a demand for gas compressors practically wherever gas is manufactured in commercial quantities.

Then another sure and growing job for the gas compressor is in three and four-stage compression for the liquefying of air and for the charging of bottles for the transportation of the various commercial gases, oxygene, hydrogen, carbonic acid, etc. Further extensions of activities in these lines are clearly indicated by the trend of present practice.

AMERICAN MINE SAFETY ASSOCIATION

The annual meeting of the American Mine Safety Association composed of leading coal and metal operators, mining engineers, mine-safety engineers, and mine surgeons will be held in Pittsburgh, Pa., September 22-24.

Since fifty-eight per cent. of all industrial accidents are shown by statistics to be due to negligence, carelessness or lack of knowledge of employers or employees, the vital necessity of learning everything possible about the causes and means of preventing these accidents must be evident to every man concerned in mining. To the operators it spells business success or failure; to the miner, life or the physical ability to work and support a family.

LONGEST TUNNEL IN SOUTH AFRICA

The Stockton tunnel, in Natal, is described by Mr. A. Colman, assistant engineer on the South African Railways, in a recent number of the "South African Railway Magazine." The tunnel is 2586 ft. long, through what is considered probably the hardest class of rock in Natal. Headings 9x9 ft. were started simultaneously at each end, but one was a top and the other a bottom heading, the former being used because the approach cut at that end was not deep enough at the time to permit a bottom heading. At the south end the top heading was driven as fast as possible, the widenings on each side following close behind, after which most of the bottom section was removed, leaving a wide enough bench along the side for a tramway to haul out the material from the heading. At the north end timber stagings of 12x12-in. timbers, with 4-in. flooring, were erected at intervals at the top of the heading after it had been widened. The headings were started about May 1, 1912; they met Feb. 22, 1913, and the excavation is now practically completed. The tunnel will be lined with concrete.

AUTOMOBILE POWER TRANSMISSION BY COMPRESSED AIR

Two Frenchmen, convinced of its value, have brought out a car in which air is made the medium through which the power of the engine is transmitted to the driving wheels. According to the system, the engine has four cylinders, set in a V, two of which act as pumps to compress the air in a tank hung to the chassis. From the tank, the air is admitted to two other working cylinders direct connected to the rear axle of the car. In operation, the system works on the same general principle as do hydraulic transmissions, with the important difference, of course, that the air is a great deal more elastic than is the oil in other systems; hence great claims are made for the air system. At present it is being tested out, and though its efficiency has not been demonstrated to be very high, it is expected that its simplicity and flexibility will overcome the disadvantage of its inefficiency. Enough air is constantly stored to make the vehicle self starting.

INGERSOLL-RAND PRODUCTS

This is a publication of 140 pages, standard catalogue size, 6 by 9 in., copiously illustrated and beautifully printed, enumerating and briefly describing the various types of air compressors, rock drills, pneumatic tools, etc., with their many developments and appurtenances. The most essential particulars as to sizes and capacities are given in tabulated form, while full details may be obtained from special publications for each item, which are furnished as they may be called for. There are 25 pages of tables and data which will be welcomed by all who have to do with the line here represented.

A vest pocket edition of the above, a complete fac simile, page for page, of the entire publication, comprises one of the daintiest and handiest business reminders ever issued. It is 4x2¾x1¼ in., bound in leather. It is something that any one would be glad to get hold of and to keep about him. Either of the above will be sent to any one who will ask for it.

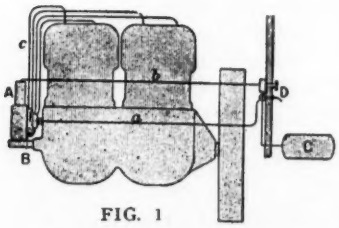


FIG. 1

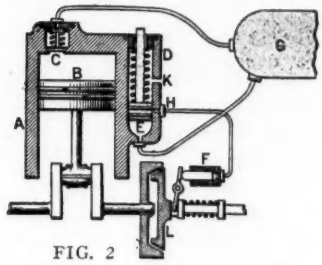


FIG. 2

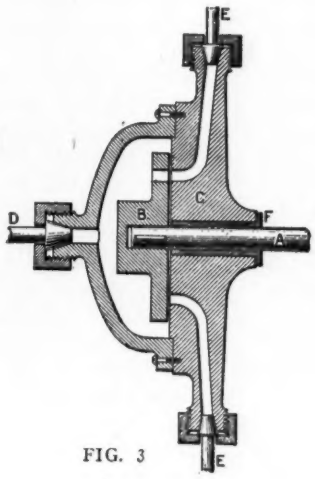


FIG. 3

COMPRESSED AIR MOTOR STARTERS

Given the choice of starting an automobile motor either by means of a special explosive charge, such as one formed from acetylene gas or by a forcible injection of gasoline vapor, or by an electric motor or by a compressed-air motor, the French market is developing a preference for the latter form of auxiliary.

Among the compressed-air devices, some act directly on the motor shaft, and others send the air to the cylinders to act upon the pistons, one after another, until the motor is running normally.

The first of these types does not depend upon finding the motor pistons in a certain position to start with and is represented in the Barbey self-starter which is used on Delaunay-Belleville cars and consists in a four-cylinder air motor mounted in front of the gasoline motor and arranged to be clutched to the motor shaft. It receives compressed air from a tank on the dash when the motor is to be started and, on the other hand, is driven by the gasoline motor when the tank must be refilled.

On account of the smaller equipment involved, greater interest attaches to the second type. It is based on the ascertained fact that a gasoline motor in good order always comes to rest with all of the four pistons at the same height and that one of them therefore always is in the position of a half-finished power stroke. If air is sent to the cylinder where

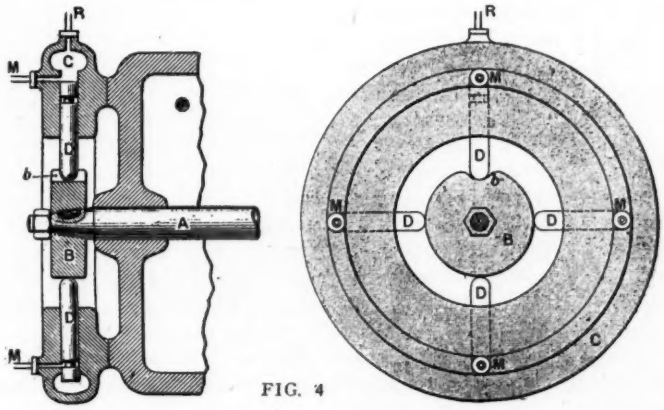


FIG. 4

the piston is in this position, it will thus act upon this piston exactly as the gas explosion acts during normal operation, and in order to effect a start safely it is only necessary to arrange a distributer device which will send air first to the cylinder which is found in the position referred to and successively to the other cylinders in the order in which they get into the same position. As soon as the speed imparted to the crankshaft is sufficient to draw an ignitable charge into one of the cylinders and to effect the compression of the same, the start is bound to follow, and the moment an explosion occurs from which the pressure is greater than that of the air, the automatic valves in the distributer cease to admit air.

All the apparatus necessary for assuring this result comprises a special distributer device connected to the different cylinders by tubes of small diameter, a special automatic intake valve for the compressed air in each of the cylinder heads and an air-tank connected to the distributer. The compressed air is usually produced by means of a small pump actuated at the driver's option from one of the gear shafts, and it is usually sent first into a small reserve tank. The general arrangement is shown in Fig. 1, in which A is the air-tank, B the distributer, C the reserve tank, D the control organs, *a* tubes from the reserve, *b* tubes to the reserve and *c* tubes to the cylinders. The distributer is the only organ presenting features not familiar from other mechanical devices. It must be so built as to avoid air leaks when it is feeding the cylinders and to avoid friction when it is not operating. Fig. 3 shows one such arrangement. A is a half-speed shaft driven from the crankshaft, B a rotary slide valve keyed to rotate with A but capable of a small longitudinal displacement on the shaft, C the distributer-disk forming one side of the air-collector in which air is received through the valve D from the air tank, E the air conduits to the cylinders, F the bushing in which shaft A turns. The air pressure holds the ground face of the rotary slide valve tightly against the distributer-disk C, as soon as air is admitted. The hole in the slide valve can be made large enough—in the form of a curved slot—to make sure that air will reach one of the cylinders when first admitted, even if the pistons are not found strictly midway between centers, and thereafter the slide valve is rotated and takes care of the successive distribution to the four cylinders. When the start is effected and the air supply is cut off, the slide valve is detached from the face of the distributer and revolves without friction. This device need only be from 2½ to 4 inches in diameter.

A somewhat different distributer is used in Delahaye fire engine motors and has so far proved itself reliable. It was designed and made by Letombe and Aucoc and is shown in Fig. 4. It forms a feature in a general arrangement like that represented in Fig. 1. This distributer has four piston valves D placed 90 degrees apart around a cam disk B keyed upon the camshaft of the motor. The space at the outer ends of the pistons is in constant communication with an annular space C in which the compressed air is received by way of R, and from which four conduits M lead to the cylinders. When air is admitted, all the pistons are pressed against the cam-disk, but only the one opposite to the notch *b* in this disk can be displaced toward the center of the device, thereby uncovering the corresponding air conduit to one of the cylinders. When the air pressure ceases, the pistons also cease to press against the cam disk and the device revolves without appreciable friction.

The intake valve for the air which must be provided in each of the motor cylinders opens from the outside inwardly and its spring must be strong enough to resist the ordinary suction of the intake stroke, for which purpose a four pound spring pressure [per square centimeter] is sufficient, even if the carbureter is throttled down.

A compressed-air motor-starter can be arranged so as to require no attention with regard to the filling of the air tanks. To this end, the compressor pump is connected with one of the shafts in the motor by a cone clutch on the plan shown diagrammatically in Fig. 2. A is the compressor cylinder with piston B and valve C connected by a tube with the air tank G. In the adjacent small cylinder D the piston E is pressed toward the bottom by a spring, against the resistance of the air pressure underneath. If sufficient to raise the piston until the port H is uncovered, the air pressure travels through a tube to the small cylinder F and drives the piston in the latter against a lever which disengages clutch L and releases the compressor shaft from the driving

snaft. Obversely, if the air pressure under piston E is low, the clutch spring pushes the clutch into engagement and puts the compressor to work. K is a safety port limiting the air pressure to a maximum, being necessary because a relief port in cylinder F, for example, would leave too small a margin of air pressure to work with, so that the clutch would be continually engaging and disengaging.

AN ILLUMINATING PROJECTILE

Deutsches Offizierblatt describes an illuminating projectile of a new type manufactured by Krupp. The projectile, built like a shrapnel, contains a number of layers of flame bulbs in a black powder matrix separated by thin annular partitions. A black powder fuse runs through the center of the projectile, like a core. The base of the projectile is filled with six "feathers" made of thin metal, which are held in place, folded up against the projectile, when it is fired. When the projectile reaches the highest point in its trajectory, an automatic arrangement releases the "feathers" at the base, arresting its flight and causing it to float in the air point downwards. At this moment the first layer of flame balls is thrown out. The other layers are thrown out successively, lighting up the field.

NOTES

Brazil has recently decided to join the great nations of the world in the use of the meridian of Greenwich for reckoning official time, it heretofore having been one of the few commercial nations to prefer its own meridian.

In patent No. 1,064,053, A. R. Coyle, Jr., of Trafford, Penn., shows a hair-cutting apparatus which is provided with cutting blades operated by means of a vacuum and the vacuum also serves to draw the hair to be cut into the path of the blades or cutters and delivers the cut hair to a suitable receptacle.

Bulletin No. 56 of the Bureal of Mines, entitled "First Series of Coal Dust Explosion tests in the Experimental Mine," by George S. Rice, L. M. Jones, J. K. Clement and W. L. Egy, which is sent free to any one who asks for it, has been prepared for the purpose of placing before the mining public an account of the objects sought in the establishment of the experimental mine of the bureau, a description of the arrangement and equipment of the mine and a detailed account of the first series of explosion tests, including a description of the recording apparatus used in connection with them.

The activity in building war materials in Russia is indicated by the consumption of gas for acetylene welding. One shop near St. Petersburg has an hourly consumption of 300 cu.m. (10,600 cu.ft.), and this for each hour of the 24. This is believed to be the largest use of gas for flame welding in a single plant in the world.

A pneumatic tire well inflated runs cooler than one "underflated", the reason being that the generation of heat is largely due to the flexing of the fabric in the casing. The lower the inflation the more the flexing, and correspondingly the greater the heat generated and the more danger of devulcanization of the rubber in the casing.

Elianite is a new alloy, prepared in the electric furnace, which is particularly resistant to acids. It is not attacked by chlorine or bromide in a free condition, by hydrochloric, sulphuric or nitric acids, or by *aqua regia* made up of three parts of hydrochloric acid to one of nitric acid. The specific gravity of elianite is 6.8 and its melting point is 1,250 degrees Cent. (2282 F.).

Notwithstanding the high prices prevailing for tin, the increase in the world's production in the last few years has been but slight, and as compared with the output of 1910, has decreased. In 1911, the world's production of tin aggregated 118,200 tons. Although tin is used extensively in the brass foundry industry, nevertheless, the largest tonnage is consumed by manufacturers of tin plate.

A recently developed branch of the aluminum industry is the manufacture of the powdered metal known to the trade as aluminum-bronze powder and used extensively as a paint pigment, in explosives, in lithographing, and in printing. To make the powder, foil made of the metal only 0.01 millimeter (0.0004 inch)

thick is cut into squares of 2 millimeters, or 0.079 inch, on a side and rubbed to a powder. The material feels like powdered graphite and is just as difficult to remove from the skin.

Ammonia bombs are being tried out on some of the national forests for the purpose of extinguishing forest fires. They are said to have worked well in the case of brush fires where the fire-fighters find difficulty in getting near enough to the burning area to beat out the flames.

It is not known what constitutes "good" air or "bad" air. Oxygen we know is necessary, but there must be something else. Some have thought that it is ozone, but this is far from proven. The scientists have never been able to locate any toxic poison in bad air. Any number of latest authorities can be quoted on the subject of the harmlessness of carbonic acid; even the fact that the amount of carbonic acid is a reliable index of other impurities is being doubted.

Eugene Gilbert, a French aviator, on August 3, flew from Paris to the town of Pejabo, on the Portuguese frontier, a distance of 1,030 miles, in an effort to win the Pommery Cup which is given for the longest flight in a single day. Gilbert beat the record of 875 miles made on June 11 last by des Moulinais, flying from Paris to Warsaw. Gilbert left Paris at 4.45 a. m., and flew for 7 hours without a stop to Victoria, in Spain, where he landed. Ascending again at 1 p. m., he headed for Portugal, and at 8 p. m. descended at Pejabo.

As an extinguisher for small fires of gasoline or oil, sawdust is better than sand. Plain ordinary sawdust, wet or dry, thrown on the blazing fluid, has a blanketing action, floating on the surface and keeping out the air, so that it actually smothers the flame. Sand is less efficient because it sinks through the liquid, and acts to smother the flame for only a short period. The efficiency of sawdust may be increased by mixing it with sodium bicarbonate, at the rate of 10 pounds of bicarbonate to a bushel of sawdust. The bicarbonate liberates carbon dioxide when heated, this gas smothering the flames.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JULY 1.

1,065,924. PNEUMATIC VALVE. AMOS F. DIXON, Newark, N. J.

1,065,974. DEVICE FOR TESTING PRESSURE, SPECIFIC GRAVITY, AND VOLUME OF GASES SAMUEL C. SHAFFNER, East Orange, N. J.

1,066,065. METHOD OF PRODUCING SO-CALLED OZONIZED AIR. JAMES TODD, Sewickley, Pa.

1,066,066. AIR-VALVE. LOUIS A. VIDY, Ogden, Utah.

1,066,189. APPARATUS FOR REGULATING THE PRESSURE AT WHICH AIR IS BLOWN INTO INTERNAL-COMBUSTION ENGINES. LUDWIG THADDAUS EBERMANN, Augsburg, Germany.

1,066,201. VACUUM-MOP. JOHN W. FULPER, Annadale, N. J.

1,066,260. PNEUMATIC STRAW-STACKER. AUGUST P. DETERMANN, Lyons, Iowa.

1,066,261. AIR COMPRESSING AND STORAGE APPARATUS. RUDOLF DIESEL, Munich, Germany.

1,066,287. VACUUM CARPET-SWEEPER. GOTTLOB KLUMPP and PAULINE KLUMPP, Bayonne, N. J.

1,066,289. VALVE-GEAR FOR RECIPROCATING STEAM AND OTHER ENGINES. STANISLAS KOLOMYJSKI, Alexandrovsk, Russia.

1,066,313. PNEUMATIC SHOCK-ABSORBER. LLOYD E. PARROTT, Topinabee, Mich.

1,066,354-5. TURN-TABLE FOR COUPLINGS. LEONIDAS DOAN WOODRUFF, Hattiesburg, Miss.

1. A turn-table for fluid pressure coupler heads comprising a stationary plate designed to be attached to the draw bar of a car coupler, a second plate pivoted to said stationary plate and adapted to receive a coupler pipe, and a lever carried by said stationary plate and adapted to engage the other plate to hold the plate carrying the pipe in different adjusted positions, as set forth.

1,066,391. PRODUCER OF INERT GASES. HERMANN VON EICKEN, Friedenau, near Berlin, Germany.

1. The combination with an internal combustion engine, of a compressor, a connection for leading the exhaust gases of the engine to said compressor, a delivery conduit, a valve controlling the passage of the compressed gases from the compressor to said conduit, a piston held to move in unison with said valve and having a face exposed to the gases contained in the delivery conduit to counteract the pressure exerted by said gases on the valve, and means for pressing the valve toward its seat.

1,066,397. PROCESS AND CONTRIVANCE FOR PRODUCTION PARTICULARLY OF SUGAR-CRYSTALS IN VACUUM. OTTO FROMM and MATHIAS SCHODLY, Schwartau, near Lubeck, Germany.

1,066,414. PNEUMATIC TOOL. HENRY E. LE GENDRE, Cresskill, N. J., and GEORGE LEICH, New York, N. Y.

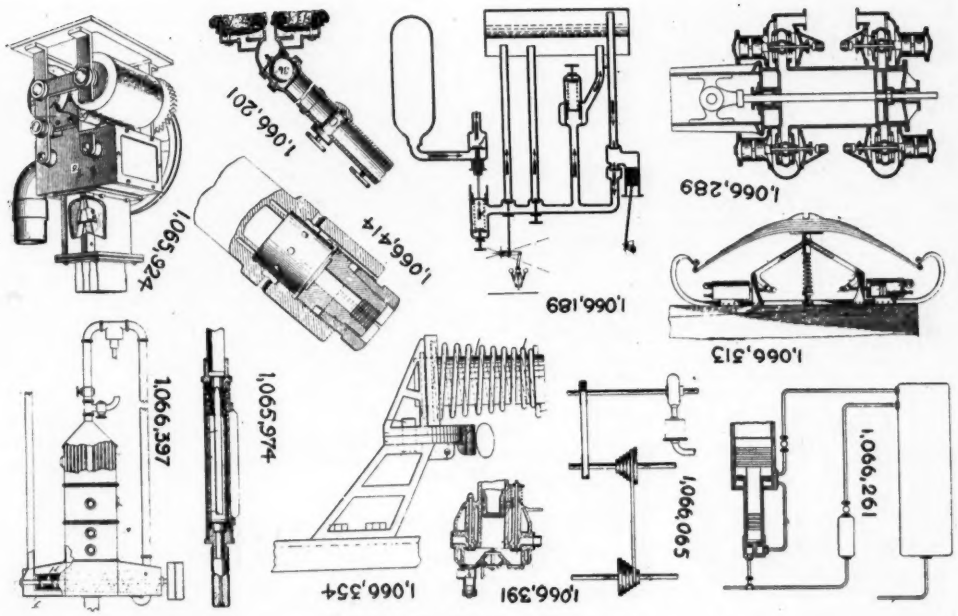
JULY 8.

1,066,483. FLUID-PRESSURE MOTOR. JOHN FOURNIA, Albany, N. Y.

1,066,484. OZONE-GENERATOR. WILLIAM O. FREET, Hackensack, N. J.

1,066,523. PROCESS FOR THE SCIENTIFIC CURING OF WOODS. FRANK A. PALEN, New York, N. Y.

1. The herein described process of curing wood, which consists in first subjecting the undried wood to combined action of a vacuum and a progressively increasing temperature, then breaking the vacuum and subjecting the wood to heat alone to produce a substantially uniform



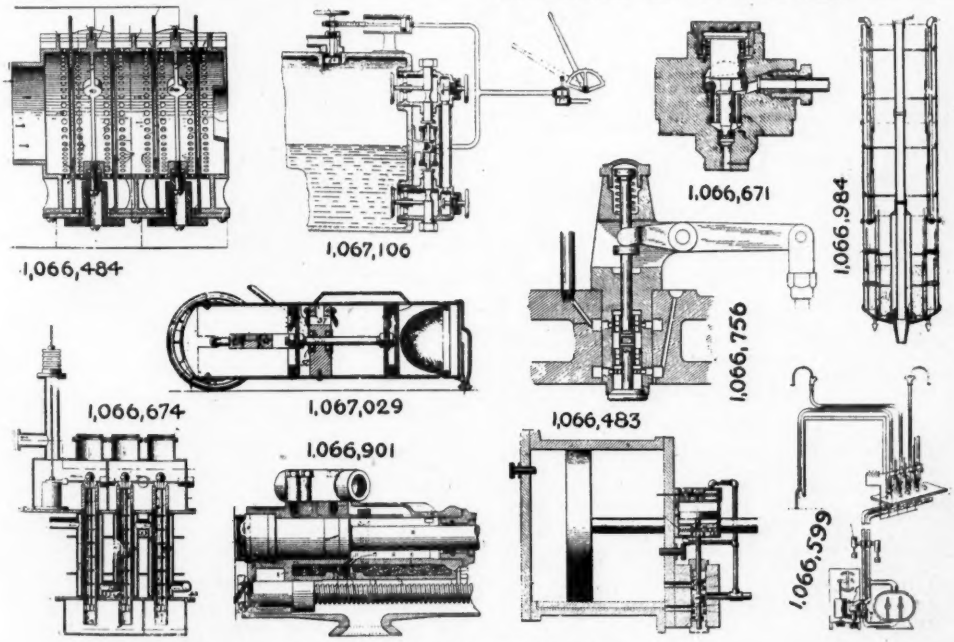
PNEUMATIC PATENTS JULY 1.

temperature throughout the entire mass without decomposition of the wood resins, and then subjecting the wood to the combined action of a vacuum and heat for causing distribution of the wood resins in an undecomposed form.

1,066,599. PNEUMATIC - DESPATCH APPARATUS. OWEN G. GILSTRAP, Portland, Oreg.

1,066,671. VALVE - ACTUATING MECHANISM FOR INTERNAL - COMBUSTION ENGINES. KARL STEINBECKER, Charlottenburg, Germany.

1. In a device of the character described, the combination of a body, a fluid pressure seated valve located therein, an acuator one end of which extends into the fluid space and acts



PNEUMATIC PATENTS JULY 8.

through lost-motion on the valve, and a means operated by a machine part for moving the actuator.

1,066,674. APPARATUS AND METHOD FOR THE PRODUCTION OF OZONE. JAN STEYNIS, New York, N. Y.

1,066,756. AIR - STARTER AND RELIEF VALVE. CLAUDE RORABECK, Dayton, Ohio.

1,066,901. ROCK-DRILL. CHARLES C. HANSEN, Easton, Pa.

1,066,927. POWER-PNEUMATIC FOR PLAYER-PIANOS. JOSEPH LEISCH, Tyron, N. C.

1,066,984. CAISSON CONSTRUCTION. EDWARD BIGNELL, Lincoln, Nebr.

1,067,029-30. PUMPING MECHANISM FOR VACUUM-CLEANERS. ROBERT B. HUTCHISON, Wilkinsburg, Pa.

1,067,106. DEVICE FOR AUTOMATICALLY CLOSING LOCOMOTIVE-VALVES. THOMAS W. GRIFFIN, Springfield, Mo., and CURTIS J. RATHERS, Sapulpa, Okla.

1. A device of the character described, comprising the combination with valved cab fittings

1,067,446. VACUUM-CLEANER. THOMAS R. SIGAFOOS, Georgetown, Colo.

1,067,500. PNEUMATIC DRILLING - MACHINE. JAMES H. BONDY, Great Falls, Mont.

1,067,607. PNEUMATIC ROLL FOR LEATHER-WORKING MACHINES. HENRY A. HOLDER, Lynn, Mass.

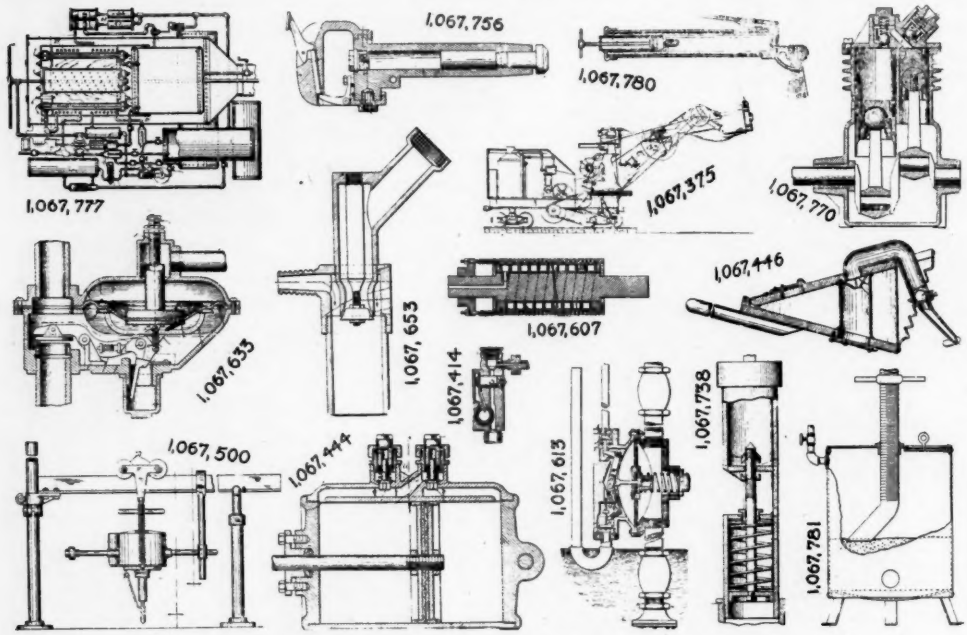
1,067,613. PNEUMATIC PUMP. GEORGE S. LANE, Portland, Oreg.

1,067,633. AUTOMATIC CHECK-VALVE FOR GAS. JOHN ZANDER, Chicago, Ill.

1,067,653. VACUUM - CREATOR. EDWARD HEARING, Kellogg, Idaho.

1,067,658. DEVICE TO TRIM HORSES' HOOFS. MICHAEL JOYCE, Jr., Burdette, S. D.

1. A device of the class described comprising as constituent parts, a casing and a tool carried by the casing, one of which constituent parts is provided with a lubricant outlet discharging upon the outer face of the tool; and a unitary means for imparting a blow to the casing and for creating *a fluid pressure* within the casing above the outlet.



PNEUMATIC PATENTS JULY 15.

the valves of which are normally open, and a source of air supply, of connections whereby to automatically close the valves upon the application of the emergency brakes, and prevent the escape of steam and boiler water into the cab in the event that the fittings are broken.

JULY 15.

1,067,375. ROCK-BREAKING SHOVEL. OLIN S. PROCTOR, New York, N. Y.

1. The combination with the dipper of any preferred type of power shovel of pneumatic hammers suitably located on said dipper for breaking rock, substantially as described.

1,067,388. ROCK-DRILLING MACHINE. DANIEL SHAW WAUGH, Denver, Colo.

1,067,414. PNEUMATICALLY - OPERATED GAS-VALVE. ALFRED NEVILLE EDWARDS, London, England.

1,067,444. SHOCK-ABSORBER. THOMAS F. SCOTT, Everett, Mass.

1,067,738. AUTOMATIC RELEASE - VALVE FOR AIR-BRAKE SYSTEMS. CHARLES W. HURL, Johnstown, Pa.

1,067,756. PNEUMATIC TOOL. EDMOND W. RAIKES, Cleveland, Ohio.

1,067,759. AIR-CLEANER AND VENTILATOR. HENRY M. ROBERTSON, St. Paul, Minn.

1,067,770. TWO - STAGE COMPRESSION-PUMP. GREGORY JOHN SPOHRER, Franklin, Pa.

1,067,771. MEANS FOR GENERATING MOTIVE FLUID FOR MOTOR-CARS. FRANK H. STANARD, Denver, Colo.

1. In apparatus of the class described, the combination of a steam generator, a dome in communication with the generator for receiving the motive fluid, a compressed air receiver, a water tank, an injector connected in operative relation with the receiver, the water tank and the generator, and means operated by the motive fluid from the dome for automatically cutting off the supply of air and water from the in-

jector to the generator, substantially as described.

1,067,780. DISTRIBUTER. FRANK J. BRINK, Cincinnati, Ohio.

The combination of a tubular container, a brush secured on one end thereof at an angle to its length, valve controlled tubular connections therefrom with the container, a cap removably secured on the other end of the container, and *an air compressor* secured to the cap for regulating the air pressure within the container in discharging the contents thereof to the brush.

1,067,781. CONCRETE-MACHINE. WILLIAM L. CANNIFF, deceased, by Roy L. Canniff, administrator, New York, N. Y.

1. In a device of the character described, the combination of a vessel adapted to contain concrete or concrete materials, provided with an opening for supplying the same to the vessel, a door for closing said opening, *means for injecting air under pressure* into said vessel above the upper surface of the concrete and a discharge pipe said discharge pipe extending from the surface of the said concrete to the outside of the vessel at a point above the said concrete and having an intake opening in proximity to the said surface, and means for maintaining the said opening in such proximity during variations in the quantity of concrete in the vessel.

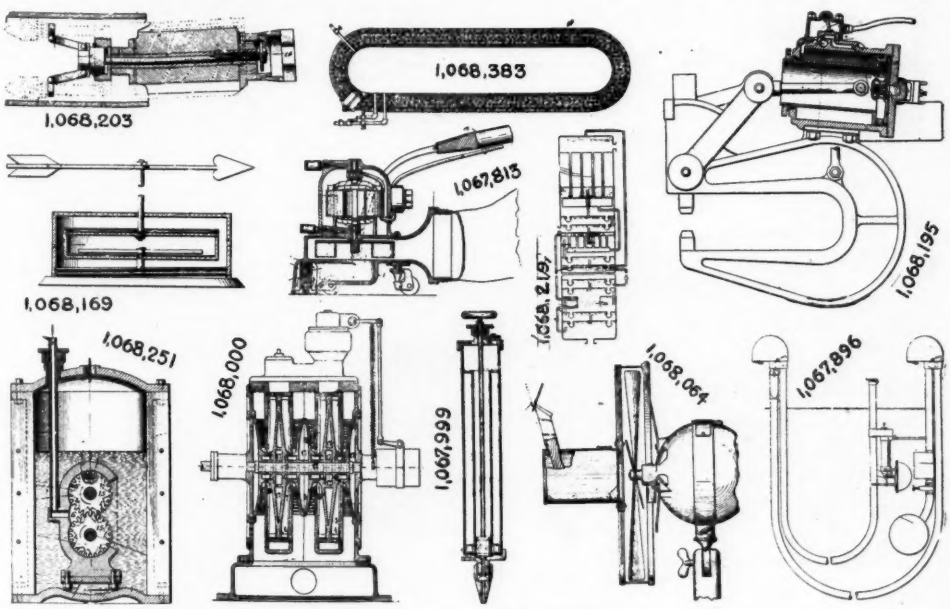
1. A fire extinguishing hand-syringe comprising in combination a reservoir, a pumping chamber adjacent thereto, a piston adapted to be reciprocated repeatedly within said pumping chamber to empty the same, said pumping chamber communicating with said reservoir at the forward and rear ends of said pumping chamber, and an air inlet valve for admitting air on the forward stroke of said piston and preventing an outward flow of air on the back stroke of said piston whereby the air in the rear of said reservoir is compressed, and the flow of liquid accelerated from said reservoir into the forward end of said pumping chamber, and means for preventing a return flow of the liquid from the forward end of said pumping chamber to said reservoir on the forward stroke of said piston.

1,068,000. COMPOUND FLUID - PRESSURE TURBINE. LEON METAIS, Charenton, France.

1,068,064. APPARATUS FOR MOISTENING, DEODORIZING, DISINFECTING, PERFUMING, AND COOLING AIR. FELIX LESSER and ARTHUR H. AVERY, New York, N. Y.

1,068,162-3. PNEUMATIC CONCENTRATING-TABLE. CLARENCE Q. PAYNE, New York, N. Y.

1,068,169. WIND - INDICATOR. GEORGE W. RICKETTS, Philadelphia, Pa.



PNEUMATIC PATENTS JULY 22.

JULY 22.

1,067,802. VACUUM-HEAD FOR COTTON-PICKING MACHINES. WOODBURY K. DANA, Westbrook, Me.

1,067,813. VACUUM-CLEANER. HARMON H. HAROLD, Canal Dover, Ohio.

1,067,896. PNEUMATIC - DESPATCH - TUBE APPARATUS. BIRNEY C. BATCHELLER, New York, N. Y.

1,067,969. PNEUMATIC ACTION FOR PIANO-PLAYER, &c. GEORGE P. BRAND, New York, N. Y.

1,067,970. WINDMILL. WILLIAM P. BRETT, Decatur, Ill.

1,067,984. AIR-GUN. WILLIAM A. HEILPRIN, Philadelphia, Pa.

1,067,999. FIRE-EXTINGUISHING SYRINGE. HIRAM MERRITT, Newburgh, N. Y.

1,068,195. POWER DEVICE. MORRIS C. WHITE and OTHO C. DURYEA, Chicago, Ill.

1,068,203. TUBE - CLEANER. THOMAS ANDREWS, Rockaway, N. J.

1,068,219. PROCESS FOR SEPARATION OF THE CONSTITUENTS OF GASEOUS MIXTURES. GEORGES CLAUDE, Paris, France.

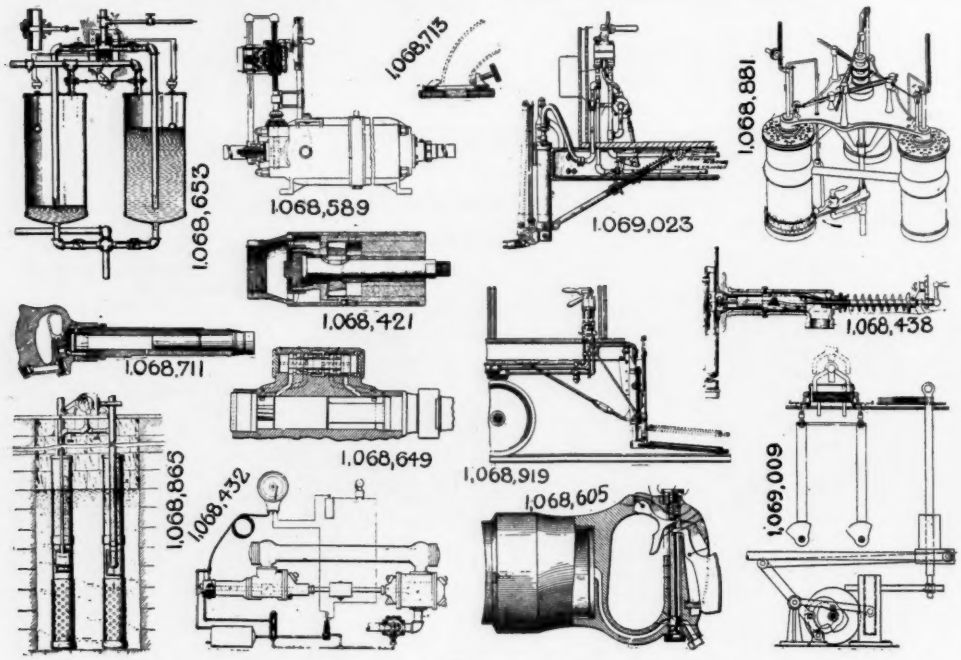
1. A process for the separation of a mixture of gases, such as air, into its constituents by way of liquefaction followed by rectification of the liquid produced, consisting in passing the compressed and cooled gases through a laterally confined space cooled by liquid collected at the foot of the usual rectification column, and then passing the remaining unliquefied gases in continuation through a second laterally confined space cooled by liquid collected in the column in a region situated some distance above the foot of the column.

1,068,228. CAISSONS AND METHOD OF JOINING THEM. JOHN W. DOTY, Brooklyn, N. Y.

1,068,251. ROTARY PRESSURE OR VACUUM PUMP. GEORGE I. LEONARD, Los Angeles, Cal.

1,068,383. CONCRETE COMPRESSED - AIR CISTERN. WILBUR T. CLARK, Buffalo, N. Y.

A cistern comprising, cylindrical concrete side walls and spherical ends, a wire mash reinforcement therefor and embedded therein, a unitary complete metallic shell disposed within the said concrete and defining a liquid-tight compartment, said metallic shell formed of thin material and adapted to retain a liquid out of contact with the concrete which forms the side walls and ends, a metallic man-hole tube extending through an opening formed in the said concrete side wall and effecting a liquid-tight joint with the said metallic shell, means for the closure of said man-hole, and means for supplying a liquid to said cistern, the delivering of the liquid from said cistern, and the supplying of a pressure above the liquid within the cistern.



PNEUMATIC PATENTS JULY 29.

JULY 29.

1,068,421. MOTOR. WILLIAM S. ELLIOTT, Pittsburgh, Pa.

1. A fluid pressure motor, comprising an outer shell, front and rear shaft bearings contained within the shell and removable from the front end of the shell, means whereby a motor element may be inserted intermediate the shaft bearings, and means at the rear end of the casing or shell for securing the parts within the shell; substantially as described.

1,068,427. ENGINE-STARTING APPARATUS. EDWARD A. HALBLEIB, Rochester, N. Y.

1,068,432. THERMAL CONTROL FOR AIR-COMPRESSORS. EBENEZER HILL, Norfolk, Conn.

1,068,438. BLOWER FOR WATER - TUBE BOILERS. JOHN MAGEE, Detroit, Mich.

1,068,589. POWER - OPERATED CONTROLLING MECHANISM FOR FLUID - ACTUATED MACHINES. REYNOLD JANNEY, New York, N. Y.

1,068,596. ELASTIC - FLUID TURBINE. CLINTON E. LONG and FREDERICK R. LONG, Berwick, Pa.

1,068,605. PNEUMATIC HAMMER. GEORGE L. ROBERTSON, Philadelphia, Pa.

1,068,635. VACUUM CLEANING APPARATUS. ELIAS B. DUNN and ARTHUR F. DUNN, East Orange, N. J.

1,068,649. VALVE FOR PERCUSSIVE TOOLS. CHARLES C. HANSEN, Easton, Pa.

1,068,675. SAFETY RELIEF DEVICE FOR GASES UNDER PRESSURE. CECIL LIGHTFOOT, Buffalo, N. Y.

1,068,711-2. PNEUMATIC TOOL. ALBERT H. TAYLOR, Easton, Pa.

1,068,713. PNEUMATIC CLEANING - TOOL. CHARLES R. THURMAN, Parnassas, Va.

1. An attachment for pneumatic tools comprising a facing member provided with a slot, a cloth facing enveloping said facing member, and a clamping plate connected with said facing member and provided with means for securing the same to the mouth of the pneumatic tool.

1,068,798. SAFETY-VALVE FOR PNEUMATIC TIRES. WARREN W. MCCREADY and JOHN G. MYERS, Pasadena, Cal.

1,068,865. PUMP. GEORGE DORFFEL, Oakland, Cal.

1,068,881. FLUID - EXPANSION ENGINE. JOSE IGNACIO FORTOUL, deceased, Caracas, Venezuela.

1,068,919. CONTROLLING - VALVE FOR FLUID-PRESSURE-OPERATED FENDERS. FRANK A. NELSON, Minneapolis, Minn., and HARRY E. GILHAM, Seattle, Wash.

1,069,009. APPARATUS FOR PNEUMATICALLY SEPARATING SHEETS. JACOB HEINRICH, Nuremberg, Germany.

1,069,023. CAR-FENDER. FRANK A. NELSON, Minneapolis, Minn., and EINAR T. FLATEBOE, Seattle, Wash.